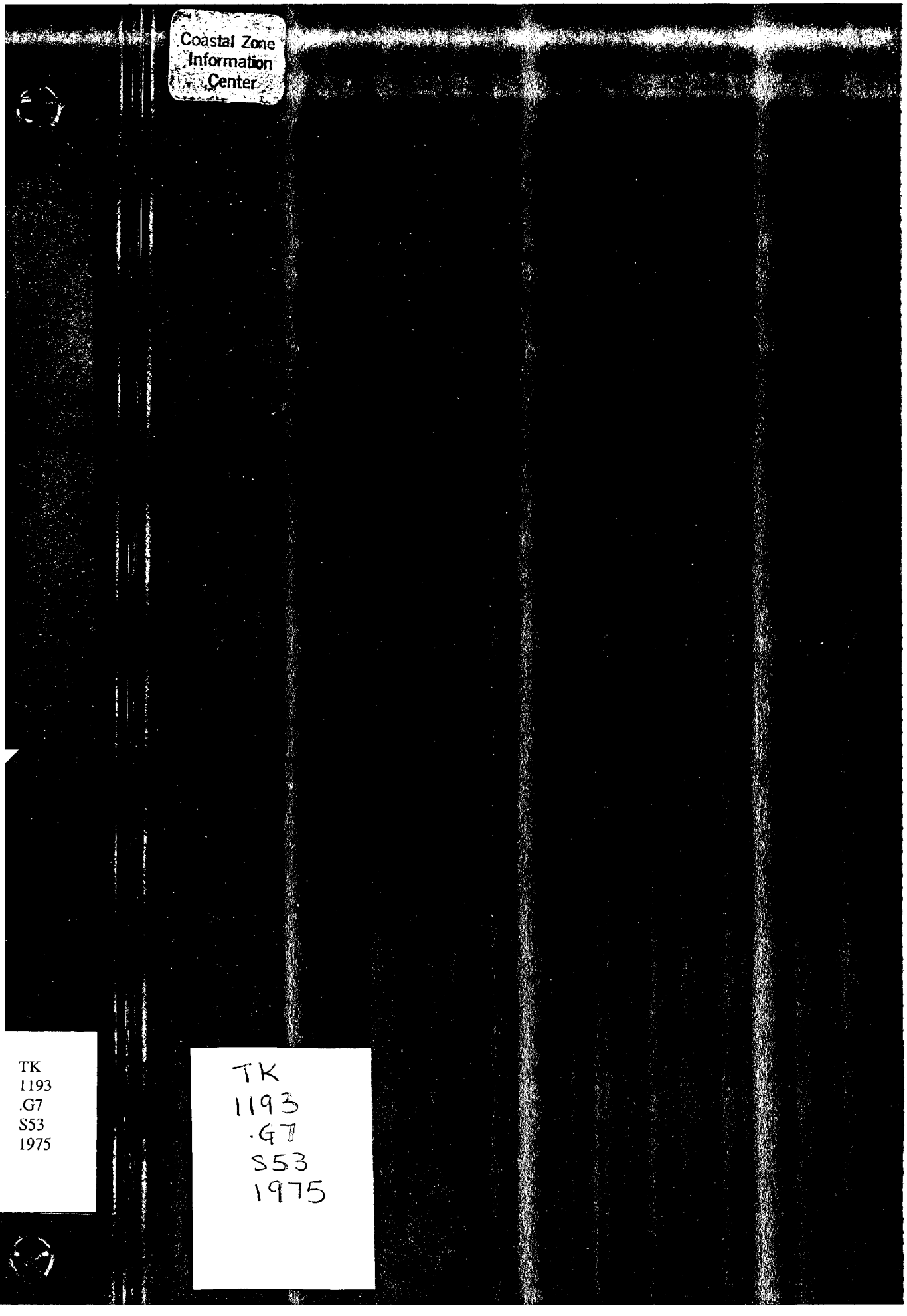

POWER PLANT SITING ISSUES AND POLICIES FOR THE GREAT LAKES COASTAL ZONE

By

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Prepared for the
Great Lakes Basin Commission
Standing Committee on Coastal Zone Management

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ABSTRACT

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Projections for future energy requirements necessitate increases in energy production. Electric energy production and thermal power cooling represents a vitally important use of the water resources of the Great Lakes. However, accelerated energy production in the Great Lakes Basin will result in increased competition for land and water resources throughout the Basin. The coastal zone of the Great Lakes is projected to be the principal problem area due to the huge amounts of water required for large thermal plants. The location of power plants, as well as the water and land resource utilization of those plants, may be in direct conflict with recreational demands, ecological stability of the littoral zones of the Great Lakes, and aesthetic requirements. Increased energy production has certain inherent potential environmental impacts, including aquatic, terrestrial, meteorological, and social, economic, and institutional impacts.

Environmental impacts of electric power generation can be minimized through intelligent power plant siting policies. Power plants should be prohibited from certain environmentally critical areas, and sited in areas most capable of assimilating the additional environmental stresses. State power plant siting laws, in conjunction with certain Federal licensing and permitting systems, represents a mechanism for controlling the location of

power plant sites and transmission corridors. State coastal zone management programs and a variety of extensive research programs are vitally concerned with power plant siting, and should provide essential information to direct the location of power plants in the coastal zone.

This paper discusses and analyzes the many issues and policies relevant to the complex problem of power plant siting in the Great Lakes Region. The paper represents a state-of-the-art assessment designed to be of value to managers and policy makers who must resolve energy issues throughout the Great Lakes Region.

ACKNOWLEDGMENTS

The author extends special thanks to those representatives of state and Federal agencies, universities, utilities, and consulting firms who generously contributed much of the information contained in this paper.

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PREFACE

The intent of the author is to discuss and analyze issues and policies relevant to power plant siting in the Great Lakes Region. The reader of this paper should not infer that the author condones continued proliferation of nuclear energy production. The environmental implications of increased reliance on nuclear energy production, including an increase in background radiation, the dangers of sabotage or accidents, the dubious safety guarantees of the Emergency Core Cooling System, the large number of highly respected scientists vehemently opposed to nuclear energy production, and perhaps most significantly, the transport and ultimate disposal of extremely toxic and hazardous radioactive wastes, raise at least a reasonable doubt as to the desirability and prudence of nuclear energy production.[1] Consequently, I support the concept of a moratorium on nuclear power plant construction contained in the Michigan House Bill No. 6126, introduced in the 1974 legislative session. This Bill would completely halt construction of nuclear power plants for a period of five years or until such time as the unresolved issues regarding nuclear power production are irrefutably and unequivocally resolved. Through energy conservation measures, increased production efficiency and increased reliance on solar energy, our society can accommodate reasonable increases in electric power demands, without depending on nuclear power. However, even if a complete moratorium on nuclear power plants was implemented, additional conventional fossil fuel plants, possibly including coal gassification or solvent refined coal, will be required and therefore, additional power plant sites must be identified and acquired.

The author is cognizant of the practical reality that this country is virtually commited to nuclear energy production. Therefore, this paper

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[1] Gofman, John W. and Tamplin, Arthur R., Poisoned Power, June 1971.

addresses the issue of nuclear power plant siting. However, in the words of Arnold Reitz, "An environmentalist having to write of nuclear-powered generating plants is a bit like a devote Hindu having to choose between hamburger or common meatballs--except that in the case of atomic energy, all choices are poisonous."[1]

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[1] Reitz, Arnold, Environmental Planning: Law of Land and Resources, 1974, pp. 17-71.

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CHAPTER ONE

INTRODUCTION

Problem Statement

The Laurentian Great Lakes, which cover approximately 95,000 square miles of surface area, constitute the world's largest body of fresh water. These Great Lakes are a major natural resource of North America and are vital to the economy of both the United States and Canada. The Great Lakes are presently utilized to satisfy a wide variety of demands placed upon them by the Basin residents. Electric energy production and thermal power cooling represents a vitally important use of the water resources of the Great Lakes. There are many important aspects of energy production that impinge upon water quality and which may degrade the water sufficiently so as to preclude further or multiple use. Numerous institutional dimensions, such as intense opposition to inter-Basin diversions, legal complexities of the riparian doctrine, and the diverse mix of governmental entities with goals which are often conflicting, are very important in relation to water for energy production. Accelerated energy production in the Great Lakes Basin will result in increased competition for land and water resources throughout the Basin. The location of power plants, as well as the water and land resource utilization of those plants, may be in direct conflict with recreational demands, ecological stability of the littoral zones of the Great Lakes, aesthetic requirements, and municipal and industrial water supplies. Increased energy production also has certain inherent potential environmental impacts. Environmental implications of increased nuclear power production, ecological impacts of thermal discharges, power plant blow-down, pelagic organism entrainment, and the possible alterations of meteorologic systems

due to thermal discharges or supplemental cooling systems are environmental concerns of great magnitude.

Projections for future energy requirements necessitate increases in energy production. In order to accommodate these reasonable increases and yet assure maintenance and enhancement of a high quality environment, while minimizing conflicts in land and water resource utilization, intelligent policy considerations and management options must be formulated. Power plant siting policies and criteria, thermal impact assessment, efficient clean energy production, and energy conservation methods are needed to accommodate energy production while minimizing detrimental environmental impacts.

The problems inherent in energy production are compounded by the complexity of the issues. These include economic, technological, social, environmental, and ecological dimensions. It should be stated at the outset that power plant siting criteria and policies are only one aspect of the extremely complex energy production scenario. Additional critical facets of this scenario include: accurate energy supply and demand projections to justify the need for additional power production;[1] total energy efficiency systems analysis;[2] and a comparative environmental impact assessment of alternative fuels and means of production. All of these should precede siting considerations. These factors must be considered at least at the regional level and preferably at the national level, as they cannot be accurately factored into an individual site-specific resolution or justification.

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[1]Personal communication, William A. Blinn, Secretary of Ohio Power Siting Commission, December 14, 1974.

[2]Personal communication, Dr. Herman Koenig, Professor at Michigan State University, October 14, 1974.

Purpose of Paper

The purpose of this paper is to discuss and analyze issues and policies relevant to power plant siting in the Great Lakes region. This will include supply-demand projections, resource requirements, environmental impacts, siting criteria, site selection methodologies, power plant siting policies at both the State and Federal levels, the relationship of coastal zone management and power plant siting, a discussion of current energy related research in the Great Lakes region, and finally, a set of recommendations pertaining to future energy policy and planning requirements. The intent of the paper is to distill a voluminous amount of information down to a reasonably comprehensive, albeit not exhaustive, document. It is hoped that this state-of-the-art assessment will be of value to managers and policy makers who must resolve energy issues throughout the Great Lakes.

Methodology

A combination of literature review and personal interviews of State, Federal, and university experts in energy policy and coastal zone management was utilized to compile the information contained in this report. Due to the sheer volume of information and the excellent assistance of many people, the primary difficulty encountered was in "wading through" and organizing the reference material and information derived from interviews into a hopefully cogent and concise presentation. The information contained in this report was assembled during the period extending from July 1, 1974 to January 7, 1975.

CHAPTER TWO

ENERGY SUPPLY-DEMAND PROJECTIONS AND RESOURCE REQUIREMENTS

Energy Supply and Demand Projections

In order to assess the total number of required power plant sites, accurate energy supply and demand projections must be made and the size of the plants must be known. Electric energy consumption is primarily related to the population size and per capita rate of consumption. In the recent past, both the growth of population and rates of per capita energy consumption have been increasing exponentially. While the Great Lakes Basin occupies only 4% of the U.S. land area, it contains about 15% of the U.S. population. The vast majority of this population is concentrated in major urban-industrialized centers located along the southern shores of the Great Lakes. The abundance of water for use in manufacturing and in transportation of raw materials, made possible by the natural waterways, has enabled the Great Lakes region to develop into a major industrial area. Many heavy energy-using industries including the steel industry, the petrochemical industry, and the automobile industry, have concentrated in the Great Lakes Basin.

Thermal electric plants now comprise approximately 88% of all the electric generating capacity in the Great Lakes region.[1] That portion is expected to increase to 90% by 1980. Predictions of the patterns of generation beyond 1980 are complicated by several factors, not the least of which is the accuracy of estimating power requirements beyond that date. Historically, the electric power industry has been one of the most dynamic in the United States, having experienced an annual growth rate of more than 5% compounded

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[1] Great Lakes Basin Commission Framework Study, Appendix No. 10, Power, Draft No. 3, November 1971, p. 57.

annually for a number of years. The technology of electric power generation and supply has been changing rapidly, resulting in a trend towards larger and larger production units.

In 1971, the Great Lakes Basin Commission Power Work Group completed projections for future energy requirements for the Great Lakes Region. They projected that the annual energy requirements would increase to 2,193 billion kWh by 2020, from 160 billion kWh in 1970.[1] This projection represents an increase of 5.4% average annual compound growth rate for the 50-year period. In view of the present energy situation, this rate of growth is probably unreasonably high. The rate of population growth has decreased slightly since these projections were made, and it is reasonable to anticipate some decrease in per capita energy consumption as the cost of energy escalates and conservation measures are implemented. The National Water Commission warns, however, "Electrical energy demands will continue to grow, even if not at the present rate of doubling every ten years. It has been pointed out that even assuming near zero population growth, a drop to one-half the present rate of growth and individual wealth, and a corresponding 50% reduction in the current rate of increase in power use in the next decade, the United States consumption of electricity will still triple by 1990."[2] The existing and most recent, albeit somewhat inflated, projected power requirements and supply for the Great Lakes region are summarized in Table 1. The Federal Power Commission is currently completing revised energy supply-demand projections. These projections for the Great Lakes Basin should be available early in 1975.[3]

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[1] Ibid., p. 58.

[2] National Water Commission, Water Policies for the Future, 1973, p. 171.

[3] Personal communication, Herbert Rinder, Federal Power Commission, December 13, 1974.

Table 1

GREAT LAKES BASIN POWER REGION

SUMMARY

Power Requirements and Supply

	1965	1970	1980	2000	2020
Annual Peak (MW)	20,641	27,944	50,138	150,769	364,639
Annual Energy Reqmnts.(10^6 kWh)	118,606	161,303	294,807	901,076	2,192,872 *
Annual Load Factor (%)	65.6	65.9	66.9	68.0	68.5
Installed Capacity (MW)					
Thermal	20,867	28,745	55,447	174,327	449,076
Hydro	4,075	4,067	5,940	6,900	10,200
Total	24,942	32,812	61,387	181,227	459,276
Net Generation (10^6 kWh)					
Thermal	98,538	129,704	287,455	949,461	2,434,475
Hydro	21,060	26,274	25,163	26,761	32,254
Total	119,598	155,978	312,618	976,222	2,466,729

Composition of the Thermal Power Supply

	Energy (10^6 kWh)	Capacity Factor (%)	Capacity (MW)	Energy (10^6 kWh)	Capacity Factor (%)	Capacity (MW)
	1965			1970		
Noncondensing	561	24	269	1,736	11	1,744
Fossil Fuel	97,796	54	20,523	123,702	56	25,173
Nuclear	181	28	75	4,266	27	1,828
Total	98,538	54	20,867	129,704	52	28,745
	1980			2000		
Noncondensing	5,761	21	3,190	26,283	20	14,948
Fossil Fuel	145,565	51	32,482	73,763	28	29,670
Nuclear	136,129	78	19,775	849,415	75	129,709
Total	287,455	59	55,447	949,461	62	174,327
	2020					
Noncondensing	75,333	20	42,858			
Fossil Fuel	36,090	43	9,500			
Nuclear	2,323,052	67	396,718			
Total	2,434,475	62	449,076			

Source: Great Lakes Basin Framework Study, Appendix 10, Power

* 5 4% compounded annually 50 yrs

It is interesting to note, however, that the Federal Power Commission still projects the same conversion trend to nuclear power embodied in Table 1, despite mounting support for a moratorium on nuclear energy production.[1]

Projected Location of Additional Power Plants in the Great Lakes Region

With respect to energy production, the principal problem area in the Great Lakes is projected to be the coastal zone of the Lakes. The majority of future thermal electric plants are expected to be installed at or near the shoreline of the Great Lakes because they will require huge amounts of water for cooling purposes. For the steam generating capacity projected to be installed in the Great Lakes by 2020, contained in Table 1, the amount of land required for thermal plants would be about 69,000 acres. This assumes that 150 to 200 plant sites are required. If all of these sites are situated on the lakeshore, a maximum of 200 miles of shoreline would be required out of about 4,000 miles of existing mainland shores.[2] In addition to the amount of land required for projected power plants, the circuit miles of transmission lines planned by 1980 will require an additional 74,000 acres of land, and those contemplated between 1981 and 1990 will require another 34,000 acres.[3] As can be seen from Figure 1, the vast majority of existing and projected power plant sites are indeed along the Great Lakes shoreline. A more recent projection of nuclear power plant siting along the Great Lakes, contained in Table 2, further serves to indicate that the coastal zone of the Great Lakes will continue to be utilized for power plant siting in the near future.

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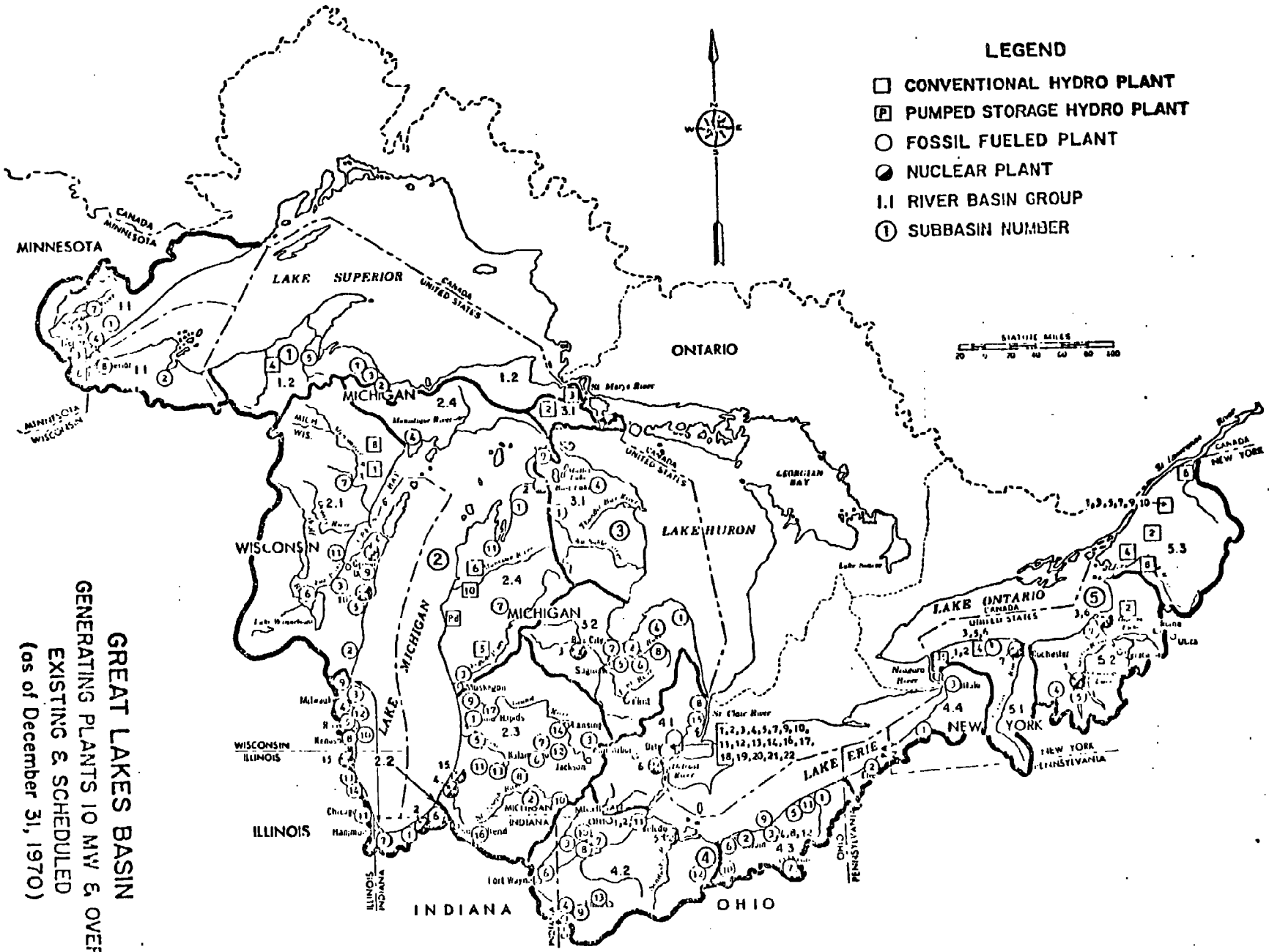
[1] Personal communication, Herbert Rinder, F.P.C., July 15, 1974.

[2] Great Lakes Basin Commission Framework Study, Appendix No. 10, Power, Draft No. 3, November 1971, p. 62.

[3] Ibid.



GREAT LAKES BASIN
GENERATING PLANTS 10 MW & OVER
EXISTING & SCHEDULED
(as of December 31, 1970)

Figure 1

Source: Great Lakes Basin Framework Study, Appendix 10, Power

PROPOSED LOCATIONS OF NUCLEAR PLANTS ON THE U.S. SIDE OF THE GREAT LAKES

Unit	City, State	MW -Thermal	(net) MW -Electric	Cooling Method	Date goes critical	Lake	Status
Bailly	Gary, Indiana	1,931	660	CCHNDCT	1979	Mich.	Being built
Davis-Besse	Port Clinton, Ohio	2,789	906	CCHNDCT	Sept. '75	Erie	Being built
Fermi no. 2	Monroe, Michigan	3,293	1,093	CCHNDCT	Aug. '76	Erie	Being built
Fermi no. 3	Monroe, Michigan	3,579	1.171	CCHNDCT	1981	Erie	On order
Big Rock Point	Charlevoix, Michigan	240	75	OT	Sept. '62	Mich.	Licensed to op.
Cook no. 1	Bridgeman, Michigan	3,250	1,060	OT	Sept. '74	Mich.	Being built
Cook no. 2	Bridgeman, Michigan	3,250	1,060	OT	Sept. '75	Mich.	Being built
Fermi no. 1	Monroe, Michigan	200	60.9	OT	Aug. '63	Mich.	Shut down
Fitzpatrick	Scriba, New York	2,436	821	OT	June '74	Ontario	Being built
Ginna	Wayne Co. New York	1,455	490	OT	Nov. '69	Ontario	Licensed to op.
Kewaunee no. 1	Carlton, Wisconsin	7	541	OT	Mar. '74	Mich.	Licensed to op.
9 Mile no. 1	Scriba, New York	1,850	625	OT	Sept. '69	Ontario	Licensed to op.
9 Mile no. 2	Scriba, New York	3,323	1,080	OT	Nov. '78	Ontario	On order
Palisades	Southhaven, Mich.	2,212	700	OT	May '71	Mich.	Licensed to op.
Point Beach no. 1	Manitowic, Wisconsin	1,518	497	OT	Nov. '70	Mich.	Licensed to op.
Point Beach no. 2	Manitowic, Wisconsin	1,518	497	OT	May '72	Mich.	Licensed to op.
Zion no. 1	Zion, Illinois	3,250	1,050	OT	May '73	Mich.	Licensed to op.
Zion no. 2	Zion, Illinois	3,250	1,050	OT	Dec. '73	Mich.	Licensed to op.

TABLE 2

(CCHNDCT) Closed Cycle Hyperbolic Natural Draft Cooling Tower

(OT) Once Through

Source: James E. Miller
Atomic Energy Commission

September 30, 1974

In addition to the large amounts of land required for future energy production, large volumes of water are also required for thermal power cooling. In 1970, 19,308 mgd of water were utilized for thermal power cooling. At the rate of energy production contained in Table 1 for the year 2020, assuming once-through cooling systems, 249,734 mgd of water would be withdrawn. Assuming all supplemental cooling, 3,963 mgd of water would be withdrawn in the year 2020.[1] In addition to the water withdrawals, the consumptive use of thermal power cooling water is also important. In the year 2020, with once-through cooling systems, 1,947 mgd would be consumptively used, and with all supplemental cooling, 3,032 mgd would be consumed.[2] The water supplies from Great Lakes sources, inland lakes and streams, groundwater, and instream or offstream reservoir storage are projected to be sufficient to meet these water withdrawal requirements. This will remain true, provided that water quality remains high enough to enable efficient and economic resource utilization. The criteria for land use, in conjunction with water use, should not be underestimated. This may be the single most important factor in facilitating or restricting increased energy production and water resource utilization for the future in the Great Lakes Basin.

Alternative Energy Futures

As suggested earlier, several factors may influence the future energy supply-demand curve and, therefore, reduce the number of projected required power plant sites. Increased prices of electricity and stringent energy conservation measures will probably reduce the per capita rate of energy consumption and thereby reduce the overall energy requirements.

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[1] Great Lakes Basin Commission Framework Study, Appendix No. 10, Power, Draft No. 3, November 1971, p. 83.

[2] Ibid.

In concluding its three-year Energy Policy Project, the Ford Foundation (1974) reports that energy growth can be cut to 2%, or less than half the current rate, without adversely effecting the economy or amenities of American lifestyles. Technological innovations, including increased efficiency of energy production and alternative production fuel sources, could also drastically alter the future energy requirements. One very real possibility is the use of solar collectors for heating and cooling of homes and office buildings. Barry Commoner asserts that, "There presently exists operational technology for using solar energy for space heating and hot water, which would represent 20% of the national energy budget."[1] He also indicates that solar collectors could be manufactured very easily in auto plants, and thereby reduce the cost substantially from the present $4,000 cost for an average home solar collector.[2] Further evidence of the reality of solar energy collectors is that Pittsburgh Plate Glass Industries now commercially markets solar collector cells which would be used for heating and hot water.[3] Although electric generation by solar energy is much further in the future, rapid technological improvements are being made. One concept that is being advocated by researchers at the University of Arizona is known as solar farms. The proposal involves covering 5,000 square miles of relatively unused land in the southwest with solar film panels which would collect the sun's heat and then be converted into electricity by huge turbines. The researchers submit that such a solar farm could harvest a billion kilowatts of electricity, which would be a substantial fraction of our energy needs

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[1] Ann Arbor News, December 12, 1974.

[2] Ibid.

[3] Environmental Science and Technology, November 1974, p. 976.

in the year 2000.[1] At the present time, a National Science Foundation demonstration house in Minnesota, a University of Delaware demonstration house, a Maryland school, and a Denver, Colorado office building are successfully utilizing solar energy for heating and cooling and supplemental energy production.[2]

Although predictions regarding future energy requirements are difficult to make, and at best tenuous estimates, it is essential for power planning and site identification and acquisition that improved projections be made. These projections should include allowances for the influence of energy conservation measures, price increases, and technological innovations, all of which may reduce the total amount of energy required and the number of sites needed. This energy planning and projection formulation should be conducted on the regional level and related to national and international projections in order to encompass entire energy systems and regional demands and supplies. This will increase the overall energy system reliability and facilitate a regional planning and policy perspective and analysis. This is essential to identify regional resource trade-offs and resolve possible interstate conflicts over siting or energy production considerations.

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[1] National Wildlife, August-September 1974, p. 20.

[2] N.O.A.A., April 1974, pp. 7-13.

CHAPTER THREE

ENVIRONMENTAL IMPACTS CAUSED BY POWER PRODUCTION AND THERMAL DISSIPATION--OPERATION AND CONSTRUCTION

Potential impacts of thermal dissipation from power production, known as "thermal pollution" has been a significant issue for several years. In 1969, the National Symposium on Thermal Pollution concluded that, "A large share of research has dealt with effects on individual species and not on biotic communities or ecosystems. Alterations should be directed toward knowing how a natural community is established and how natural aquatic ecosystems are structured and function."[1] The topic of thermal discharges was the central theme for discussion at the Michigan Governor's Conference on Thermal Pollution, held July 18, 1969. Thermal power cooling systems, power consumption projections, potential impacts on aquatic systems, and feasible solutions to thermal dissipation were discussed at this conference.[2] Lake Michigan has specifically received a great deal of attention by the United States Department of the Interior. The economic and engineering feasibility of alternative cooling methods and their impacts on the environment were discussed in a 1970 publication.[3] In a second document by Dept. of Interior, the physical and ecological impacts of thermal dissipation into Lake Michigan were examined. This document asserted that thermal dissipation into Lake Michigan could warm a significant portion of the littoral zone of the Lake and could accelerate eutrophication of the littoral zone in areas

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[1] Krenkel and Parker, Biological Aspects of Thermal Pollution, 1969, p. 384.

[2] Governor's Conference on Thermal Pollution, 1969, pp. 4-8.

[3] U.S. Dept. of Interior, Feasibility of Alternative Means of Cooling for Thermal Power Plants Near Lake Michigan, September 1970.

where nutrients are approaching critical levels.[1] Based on the evidence discussed in this report, the Fish and Wildlife Service concluded that only slightly elevated temperatures, if improperly timed and sufficiently long, could be critical to the life stages of Lake Michigan species.[2] In 1972, MIT investigated issues in electric power production, shoreline recreation, and air and water pollution of relevance to New England and the nation.[3] Also completed in 1972 was an excellent document written by the National Academy of Engineering. This document analyzes issues of environmental protection and energy production, power plant siting and transmission corridor selection, and the relationship between energy and economic growth.[4] In 1973, the Council on Environmental Quality published a book which discussed impacts of energy production, factors causing increases in energy consumption, and total energy systems impact analysis.[5] An extensive and comprehensive analysis of environmental issues caused by energy production was completed in October 1973 by John Clark. This document analyzes the value of coastal ecosystems and impact on these systems, both internal and external, to power plant siting and operation.[6] The United States Geological Survey, in 1974,

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[1] U.S. Dept. of Interior, Physical and Ecological Effects of Waste Heat on Lake Michigan, September 1970, pp. 86-87.

[2] Ibid., p. 90.

[3] Massachusetts Institute of Technology, Power, Pollution and Public Policy, 1972.

[4] National Academy of Engineering, Engineering for Resolution of the Energy-Environment Dilemma, 1972.

[5] Council on Environmental Quality, Energy and the Environment--Electric Power, August 1973.

[6] Clark, John, Electric Power Plants in the Coastal Zone: Environmental Issues, October 1973.

completed an analysis of water requirements for expanding energy development throughout the nation. This analysis of water demands includes steam electric generation, oil shale production, coal gassification-liquifaction, and extraction transport and refining parameters.[1]

Thermal power production impacts the environment in many ways during both construction and operation phases. Impacts on aquatic environments, terrestrial ecosystems, meteorological systems, and social and economic impacts are all extremely important dimensions of the energy production scheme. These impacts, as well as common impacts resulting from construction of power plants, will be discussed in the sections that follow.

The Coastal Zone--Pressures and Principles

The pressures for resource utilization, competition among conflicting demands, and the threat of imminent destruction of an invaluable resource is perhaps stronger within the coastal zone than is evident elsewhere with our land and water resources. With over 4,000 miles of Great Lakes shoreline, the coastal zone of the Great Lakes represents a tremendous natural resource. The coastal zone of the Great Lakes is utilized extensively for harbors and marinas, industrial location, power plant sites, second-home subdivisions, valuable fish and wildlife habitat, and a wide spectrum of recreational demands.

The coastal zone is the interface between the water resources and the adjacent shoreland resources. Determination of the coastal zone boundary depends on the location along the shoreline and the specific state which the shoreland lies in. Many states have adopted a rather arbitrary definition of the coastal zone which extends 1,000 feet beyond the [illegible] level.

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[1] U.S. Geological Survey, "Water Demands for Expanding Energy Development", Circular 703, 1974.

Other states are looking at a more physical definition of the coastal watershed as a delineation for the coastal zone. The coastal watershed is defined as a "drainage basin immediately adjacent to coastal waters, which is comprised of lands, all or some of which drain directly into coastal waters, and does not include lands of drainage basins that drain wholly into tributary channels to coastal waters".[1] These shorelands are included in the definition of the coastal zone because they have a potential for significant impact on coastal waters. These shorelands must be included in any coastal zone management program in order to protect coastal waters from degradation by sediment, nutrient and toxic pollutants, to maintain the hydrologic balance of the coastal zone, or to preserve the source of coastal beach materials.

The ecosystems of the coastal zone are usually ecologically complex and exceptionally rich. Characteristically, the coastal zone tends to be more productive than either the open water on one side or the adjacent land on the other.[2] Several extremely important ecological parameters of the coastal zone are: the ecological systems integrity; water as a linkage transport medium; inflow of water into the coastal zone; coastal zone water circulation; flow and amount of available energy; capabilities for energy storage; concentration of available nutrients, principally nitrogen and phosphorus; depth of light penetration; temperatures; and dissolved oxygen content. Additional physical parameters of importance in the coastal zone include: beach composition; impacts of waves and winds; the importance of littoral sediment transport; impacts of storms; and the disruption of the natural physical processes by man, including breakwaters, groin structures,

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[1] Clark, John, Coastal Ecosystems, p. 167, 1974.

[2] Odum, E. P., Fundamentals of Ecology, 1971.

jetties, and other shore protection devices.[1] These physical and biological parameters of the coastal zone are combined in many ways to provide for an almost infinite variety of coastal systems. Barren sand dunes, rocky shores and bluffs, fertile estuarine systems, and semi-enclosed coves, are examples of the great heterogeneity of coastal ecosystems. Each of these various types of coastal ecosystems has its own inherent tolerance for development, and each must be managed accordingly and individually. This diversity inherent in coastal ecosystems is important in another dimension. Ecologists frequently speak of the "health" or stability of an ecosystem and measure this stability in terms of the ability of the ecosystem to resist disturbance, or maintain itself from external perturbations.[2] Habitat and species diversity are critical factors in an ecosystem's ability to tolerate external pressures. These pressures may be natural, such as a temporary change in climate, or they may be man-caused, such as dredging and filling activities, or a temporary influx of nutrients. The greater the diversity of both habitat and species of the ecosystem, the higher the probability of the ecosystem maintaining its stability. According to Cooper, "Any form of landscape planning must consider the stability characteristics of the resident ecological systems.", and this certainly applies to management of the coastal zone.[3]

The coastal zone contains many of the most ecologically valuable components to be found in the Great Lakes. In many areas of the coastal zone,

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[1]U.S. Army Coastal Engineering Research Center, Shore Protection Manual, Volume I, pp. 1-21, 1973.

[2]Odum, E. P., Fundamentals of Ecology, 1971.

[3]Cooper, William E. and Vlasin, Raymond D., "Ecological Concepts and Applications to Planning", in Environment: A New Focus for Land Use Planning, National Science Foundation, 1973.

such as Saginaw Bay, Lake St. Clair, Green Bay, and Maumee Bay, extensive wetlands provide invaluable ecological functions, such as prime breeding grounds for many species of fish and wildlife, valuable wildlife habitat, nutrient and sediment buffer zones which purify surface run-off, and the rooted aquatic plants provide a natural mechanism for shoreline protection.[1] A wide variety of estuarine ecological systems are also found along the coastal zone of the Great Lakes which serve many of the same functions as wetlands. Both estuaries and wetlands are areas of critical environmental and ecological value. The rooted aquatic vegetation found in wetlands and estuaries also provides a valuable hydrologic function in that they serve to regulate the flow of run-off water.[2]

In addition to the ecological value of the coastal zone, there is an extremely important economic dimension. An intense competition for shoreland resources exists among industrial complexes, thermal power generation plants, and the desire for recreational and residential developments along the shoreline. It should be stressed that the recreational pressures on the shoreline represent a significant source of competition for resource utilization. The ecological significance of the coastal zone and the desire for public access and recreational facilities, as well as quality sport fishing, are vitally important to the Great Lakes Basin economy, as well as to the resident's enjoyment. Therefore, the location of industrial complexes and power plants may be in direct conflict with the recreational demands, ecological values, and intelligent natural resource management.

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[1] Clark, John, Coastal Ecosystems, p. 68, 1974.

[2] Ibid., p. 68.

Aquatic Impacts Caused by Power Plants

While water availability, per se, does not represent a significant obstacle to increased energy production in the Great Lakes, several other facets of water resource development represent potential constraints to increased energy production. There are many aspects of energy production that impact upon water quality and may degrade the water sufficiently so as to preclude further use. The discharge of power plant cooling water into lakes or streams, sometimes known as thermal pollution, may degrade water quality sufficiently to affect either species diversity or abundance. The environmental impacts of waste heat are very difficult to completely determine because heat is not persistent and does not build up in the water like chemical pollutants such as nutrients or pesticides. Another important dimension is that receiving waters naturally undergo daily and seasonal temperature flucuations which are quite often very pronounced.[1] Temperature is an extremely important water quality parameter which regulates the life cycle of many organisms in the aquatic environment. The United States Environmental Protection Agency has summarized the detrimental impacts of artificial temperature increases as follows:[2]

> "1. Heat affects the physical properties of water such as density, viscosity, vapor pressure, and solubility of dissolved gasses. Consequently, such processes as the settling of particulate matter, stratification, circulation, and evaporation can be influenced by changes in temperature. Since the solubility of oxygen in water decreases as temperature increases, thermal pollution reduces the oxygen resources. Most aquatic organisms depend on dissolved oxygen to maintain growth and reproduction.

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[1] Michigan Water Resources Commission, Thermal Discharges and Water Quality Control, June 1974, p. 5.

[2] U.S. Environmental Protection Agency, "Proceedings in the Matter of Pollution of Mt. Hope Bay and Its Tributaries", (2 volumes), 1972.

2. Heat affects the rate at which chemical reactions progress, and it can speed up the formation of undesirable compounds or change dynamic chemical equilibria. It also effects the biochemical reactions and can result in a more rapid depletion of the oxygen resources. If sufficient heat is added, temperatures can be elevated enough to sterilize the environment by killing all living organisms.

3. Environmental temperatures are important to the living resources. Physiological processes such as reproduction, development, and metabolism are temperature dependent. The range of many species of fishes and the species composition of the communities are governed to a great extent by the environmental temperature. Temperature anamolies also can block the passage of anadromous fish, greatly reducing future populations. An increase in temperature can result in synergistic actions; that is, the simultaneous effects of separate agents is greater than the total sum of individual effects. Prime examples are increased toxicity of some materials, increases in susceptibility of fish to diseases, and increased virulence of fish pathogens.

4. Thermal pollution affects other aquatic organisms such as the aquatic plants, the benthos, and the bacterial populations. Increased temperatures may reduce the number of species in the community and stimulate excessive populations of individual species to nuisance conditions."

One other potential water quality problem associated with cooling water usage is the use of chlorine to keep aquatic growths from "fouling" the plumbing of the plant. Chlorine is discharged with the cooling water and, if the residual concentration is great enough, may have detrimental effects on aquatic organisms in the discharge channels or the receiving waters.[1] This "blow down" water is frequently concentrated in supplemental cooling systems. When released from the plant, this water represents a significant potential contribution to water quality degradation. Further research conducted by the National Environmental Research Center in Corvalis, Oregon demonstrated that zinc and chromium compounds, which are frequently included in blow down water, are also very toxic components, and that synergistic effects may occur in other mixtures containing a

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[1]Michigan Water Resources Commission, "Calculated Residual Chlorine Concentrations Safe for Fish", April 1973.

variety of compounds.[1]

For many years, the primary ecological concern about power plants, other than the dangers of nuclear energy, was thermal pollution. A recent investigation into the impacts of power plants in the coastal zone concluded that the preoccupation of environmentalists with thermal pollution was not justified and that the most detrimental impact to aquatic ecosystems was the extremely high mortality of organisms suspended in the water and drawn into the power plants with the cooling water.[2] The environmental impacts resulting from massive entrainment and death of organisms such as plankton and larval stages of many fish species, in combination with the impingement of large fish on intake screens, is of great magnitude. Many species of fish are quite commonly attracted to the vicinity of power plants in colder seasons of the year due to the higher temperatures of the effluent waters. Once these fish are near the plant, they are extremely vulnerable to impingement and almost certain death on the intake screen. Many species of fish, particularly the smaller species, become entrapped on the intake screen simply because they are unable to overcome the force of the water being pumped. It appears that exhaustion, suffocation, and external and internal mechanical impacts are the primary mechanisms of fish mortality caused by impingement on power plant screens.

Many forms of life small enough to go through the power plant screens face several lethal hazards in passage through the cooling system. The resulting loss of organisms is frequently referred to as entrainment kill. As the

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[1]Gartin, R. B., "Biological Effects of Cooling Power Blow Down", 1973.

[2]Clark, John, Electric Power Plants in the Coastal Zone: Environmental Issues, 1973, p. 1.

cooling water passes through the plant, the temperature increases drastically as it passes through the condensor tubes, dissolved oxygen is usually greatly reduced, and increases in pressure and nitrogen often result in a gas imbalance. Fish larvae and plankton organisms are greatly stressed and often suffer almost complete mortality.[1] This problem is especially dramatic in estuaries and coastal zones habitats because a substantial portion of species stock can be eradicated by this entrainment kill. Estuarine species and coastal zone species typically have suspended young stages that are vulnerable to entrainment and are frequently concentrated in limited areas within the coastal zone. Entrainment kill of these suspended organisms appears to be an extremely serious impact of power plants with once-through cooling systems that are located in estuaries or prime coastal zone breeding areas. The magnitude of this impact is illustrated by the case of the Indian Point Power Plant, located on the Hudson estuary. Up to 30% or more of the annual brood of an estuarine spawning fish, such as the Striped Bass, can be killed by the operation of one 1,000 megawatt plant located in a prime breeding area such as the Hudson estuary.[2] The overall combination of thermal shock and power plant entrainment kills a great deal of fish food in the littoral zone as well as reducing the number of viable fish larvae. The littoral zones of the Great Lakes represent the most biologically productive portion of the Basin. The possibilities of disruption of the food chain, impacts on fish populations, alteration of species diversity-abundance relationships, and the reduction of ecological systems stability of the littoral zone are all extremely important ecological considerations.

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[1] Marcey, Barton C., "Survival of Young Fish in the Discharge Canal of a Nuclear Power Plant", in Journal of Fisheries Resources, p. 1058, 1971.

[2] Atomic Energy Commission, Final Environmental Impact Statement--Indian Point No. 2, 1972.

Terrestrial Impacts

Accelerated energy production in the Great Lakes Basin will result in increased competition for land resources throughout the Basin. For example, recreational pressures on the lake's shorelines represent one significant source of competition for resource utilization. The ecological significance of the littoral zone, as well as the public's desire for access to it for recreation and sport fishing, make it vitally important to the economy and quality of life in the Basin. Many people go to the shorelands of the Great Lakes seeking a psychologically rejuvenating experience. Therefore, it is obvious that the location of power plants, as well as the water and land utilization of those plants, may be in direct conflict with recreational desires and demands.

Another very significant potential area of conflict is in relation to land use allocations for power plant sites and transmission line corridors. As indicated earlier in this report, the projected requirement of as much as 200 miles of Great Lakes shoreline, as well as thousands of acres of land throughout the Basin for transmission corridors, represents a significant demand on the land resources in the Basin. At the same time, there is dramatically increasing demand for agricultural output, forestry products, wetland preservation, and residential and urban expansion. It is readily apparent that conflict among these various competing land uses is imminent. It should also be emphasized that the construction and location of a power plant are essentially irreversible commitments of land resources. Consequently, should a power plant be located on prime agricultural land, this land would be lost from agricultural productivity. This might be especially important in areas where the micro-climatic conditions, created by the lakes along the shoreline, provide the necessary environment for very lucrative vineyards and cherry and apple orchards.

Additional terrestrial impacts resulting from power plant location include possible wildlife habitat destruction or alteration, adverse aesthetic impacts, and the disruption and alteration of the coastal watershed hydrology, resulting in artificial flow characteristics and increased sediment and nutrient input. Power plants located along the coastal zone frequently have jetties or harbor-like structures protruding into the littoral zone. These structures frequently disrupt the natural littoral sediment transport patterns, resulting in accelerated shoreline erosion down drift from the structure. Countless examples of this accelerated erosion can be found along the Great Lakes shoreline by examining the numerous harbor and groin structures.[1] Between 1970 and 1974, the period of recent extreme high lake levels, a tremendous amount of erosion and property loss has occurred along nearly all of the coastal area of the Great Lakes. Lakes Erie, Huron, and particularly the east coast of Lake Michigan, have been the location of severe shoreline recession. Many millions of dollars in property loss and damage from both erosion and flooding has been suffered by public facilities and private real estate. The disruption of the natural littoral drift patterns can result in very severe consequences and represents a significant impact to shoreland resources.[2]

Meteorological Impacts

Electric energy production exerts pressures on many aspects of complex meteorological systems. Operation of conventional fossil fuel plants usually results in the increased discharge of various air pollutants including particulate matter, oxides of sulphur, oxides of nitrogen, carbon monoxide,

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[1] Larson, Curtes E., "The Cultural Variable and Shore Erosion Along the Illinois Shore of Lake Michigan", December 1972, p. 3.

[2] Ibid., p. 20.

and many hydrocarbons.[1] A major source of mercury in the environment is the tremendous quantity of mercury released each year from consumption of fossil fuels. This significant source of mercury is largely discharged to the atmosphere, and may reenter the terrestrial or aquatic environments by fallout or precipitation.[2]

The total impacts of power plant thermal discharges and supplemental cooling systems on various meteorological systems are not well understood. As more and more power plants are located along the shoreline, the potential for substantial alteration of the meteorological systems of the Great Lakes becomes more significant. It is possible that these long-range potential hydrologic and meteorological alterations represent more deleterious environmental consequences than those experienced by once-through cooling systems.[3] Presently, the atmospheric effects of waste heat dissipation are currently observed to be of only slight significance. However, the Atomic Energy Commission is currently evaluating about a dozen sites for power parks, where huge amounts of power will be generated in concentrated locations. The energy released in the form of sensible heat combined with the moisture dissipation from these power parks may result in very significant meteorological impacts.[4] Until these relationships are thoroughly understood, these operations should be viewed with concern and consideration given to possible constraints on this form of concentrated energy production. The potential for weather modification, including cloud formation, increased

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[1] National Academy of Engineering, Engineering for Resolution of the Energy-Environment Dilemma, 1972, p. 36.

[2] Donaldson, William T., Mercury in the Environment, December 1973, p. 3.

[3] Personal communication, Dr. William Cooper, Mich. State University, October 3, 1974.

[4] Hanna, Stephen R., "Research Needs Related to Hydrometeorologic Aspects of Future Energy Production", November 1974, p. 120.

precipitation, fogging and icing, as well as the alteration of the growing seasons, represent environmental consequences of great magnitude. Accelerated thermal dissipation into the Great Lakes Basin must not be allowed to occur until the consequences of such actions are fully understood.

All of the various cooling methods available for installation today have certain inherent advantages and disadvantages. Flow-through cooling systems have the lowest economic cost and the least consumptive use of water, but have an inherent danger of exceeding the natural thermal assimilative capacity of the receiving water, with resulting ecological damages. Potential entrainment problems are also greatest with flow-through cooling systems. Cooling ponds can be used for multiple-use purposes, including recreation, but have extremely large land requirements and are relatively inefficient in dissipating thermal heat, especially during extremely humid or hot climatic conditions. Wet cooling towers, either natural draft hyperbolic towers or mechanical draft towers, reduce the cooling water temperature, but increase dramatically the consumptive use of water, result in increased energy consumption and large capital expenditures, contribute greatly to aesthetic quality deterioration and have a significant potential for fogging and icing. Another possible cooling alternative is the spray canal system. This has several advantages, including reduced land requirements and efficient thermal dissipation, but presently the systems require tremendous maintenance costs and do not adequately control thermal discharges.[1] Another cooling option, dry cooling towers, greatly reduce the consumptive use of water, but are tremendously expensive and greatly increase energy allocations to the cooling

[1] Croley, Thomas and Kennedy, John, "Research Needs Related to Heat Dissipation from Large Power Plants", November 1974, p. 120.

process which detract from the overall power plant productivity.[1]

It is obvious that the Great Lakes contain a tremendous body of fresh water. A dimension of the Great Lakes that is frequently overlooked is that the natural thermal assimilative capacity is a natural resource and should be utilized, provided that detrimental environmental impacts are adequately controlled and/or mitigated. According to the National Water Commission,"The capacity of water to absorb and dissipate heat is a valuable resource which, under many conditions can be safely used."[2] The Commission further asserts that "Using water bodies to accept waste heat provides two major benefits:

1. Water as a solution, dispersion, and dissipation medium is four and one-half times more efficient than air on a weight basis and forty-two times more efficient on a volume basis, and

2. The improved efficiency of the cooling process reduces the allocation of resources and the production of energy otherwise required for this function."[3]

In view of the potential detrimental environmental impacts and increased requirements of capital and energy of the various cooling alternatives, once-through cooling systems should not be arbitrarily eliminated from consideration. Properly sited and designed power plants, utilizing once-through cooling systems along Great Lakes shorelines could result in fewer adverse environmental impacts, reduced energy and economic costs, and result in efficient resource utilization.

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[1]Furlong, Don, "The Cooling Tower Business Today", in Environmental Science and Technology, August 1974.

[2]National Water Commission, Water Policies for the Future, 1973, p. 175.

[3]Ibid., p. 176.

Social, Economic, Institutional Impacts

In the case of power plants, as with any important installation, there are numerous social, economic, and institutional dimensions, both positive and adverse. In many sections of the Basin, reliable energy sources are vitally important to the region's economy. Real or perceived energy-related needs can exert a tremendous influence on a community. The intense opposition or adament support for nuclear power production can completely fragment the community's social and economic foundation. It is extremely important that adequate technical assistance be provided to local political bodies which would lead to an early identification of economic dis-benefits to local interests, as well as benefits, and lead to the establishment of a more equal distribution of benefits and costs.[1] Several important direct and indirect impacts of construction and operation of a power plant on local public facilities are increased school enrollment, increased demand on police fire, and recreational facilities, and increased demand for housing, which frequently results in temporary increases in rental payments. Positive economic impacts of the facility on the local community include increased payroll and employment opportunities, increased property tax revenues, and increased demand for service and supply businesses.

Secondary impacts on the local socio-economic structure resulting from energy facilities should also be considered. These may include an influx of new industries into the area due to the availability of assured energy supplies at a reasonable price. These additional industries may exert significant pressures on the community's sewage treatment plant and municipal water supply systems. Therefore, it is not sufficient to analyze

[1] Williams, J.S. and Spiegel, S., Socio-Economic Impact of Estuarine Thermal Pollution, 1974.

only the immediate site-specific impacts, but it is important to look at entire community-wide impacts, both primary and secondary. Such impacts as increased air pollution, higher levels and greater intensities of noise, aesthetic deterioration of the community, destruction of important historical and archaeological sites of the community, are all critical facets that should be considered in a comprehensive analysis.

An institutional conflict of long standing in the Great Lakes Basin is the issue of inter-basin diversions. Historically, the opposition to inter-basin transfer often has varied inversely with lake levels. As the lake levels have increased, more and more people have become amenable to the idea of diverting excess water out of the Basin. However, when the lake levels recede, residents intensely oppose the loss of lake water through inter-basin diversions. Future proposals for additional inter-basin diversions, as well as suggestions for Federal jurisdiction over water rights in order to facilitate alledgedly more efficient water resource utilization, will meet with strenuous opposition from many private and governmental entities throughout the Basin. In addition, the constitutional implications of Federal jurisdiction over water rights are extremely complex and serious.

Another potential institutional problem area is associated with the legal concept of riparian rights in the Great Lakes Basin. Under the Riparian Doctrine, all water withdrawals must be reasonable in their scope. They cannot contribute significantly to water quality degradation, nor can they interfere with other legitimate riparian interests. Therefore, any dramatic increase in consumptive use or degradation of water quality due to water utilized for energy production in the Basin will be in direct conflict with this doctrine.[1]

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[1] Walker, William R. and Cox, William E., "Legal Aspects of Water for Coal Gassification", November 1974.

The diverse mix of governmental institutions operating on several levels within the Great Lakes Basin also represents a potential problem area with respect to energy production. Conflicting goals, uncoordinated planning, and poor management of policy formulation all prevent efficient and beneficial resource utilization in the Basin. The planning and management of water and related land resources relating to increased energy production throughout the Basin is an example of an area in which the Great Lakes Basin Commission should be intimately involved. The Commission should facilitate socially desirable, environmentally compatible, economically feasible, and politically tenable resource policy and plan formulation. The Commission is charged, under the Water Resources Planning Act of 1965 (P.L. 89-80), to coordinate the land and water resources planning within the Great Lakes Basin and to prepare a comprehensive coordinated joint plan. Energy-related planning and policies are an integral part of this comprehensive coordination and planning effort.

Construction Impacts

According to John Clark, "The disruptions consequent to power plant construction are a potential source of significant adverse effects."[1] Estuaries and adjacent wetlands are especially vulnerable to impacts from shoreland construction, such as destruction of wetlands and bay bottom habitat; degradation of wetlands through alteration of the hydrologic regime; and a detioriation of water quality resulting from agitation and suspension of sediment and an influx of nutrients. Several major potential disturbances to coastal ecosystems are set forth by Coutant as follows:[2]

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[1]Clark, John, Electric Power Plants and the Coastal Zone: Environmental Issues, 1973, p. 12.

[2]Coutant, Charles, "Evaluating the Ecological Impact of Steam Electric Stations on Aquatic Systems", December 1972.

"Dredging for an intake channel or discharge pipeline is the construction activity which can have the greatest impact on aquatic biota. Removing sediments from fresh water is known to have potential for biological damage to populations (1) in the immediate area of dredging (by disruption of bottom organisms in the habitat); (2) in areas of intentional disposal of dredge materials (by covering existing bottom organisms and modifying habitats); (3) in unexpected areas within the general region where water quality may be altered (increased turbidity, reduction in quantity of dissolved oxygen due to suspension of oxygen-demanding sediments, release of toxic materials, etc.) or bottom organisms that are covered by smothering siltation. Dredging new channels in water bodies or marshes, or as outlets for bays, may significantly change existing circulation patterns and greatly modify aquatic habitats."

The extensive estuarine or coastal zone marsh landscapes offer especially attractive sites for power plants, particularly nuclear sites because the price per acre of marsh land is relatively low and frequently a high degree of isolation is possible. Power plant siting in these areas conflicts with state and national programs for the protection of critical wetlands. The many policy alternatives for regulating development in these critical environmental areas will be discussed in subsequent chapters.

Hittman Associates prepared a general environmental guideline for evaluating the effects of nuclear power plant site preparation and transmission corridor construction for the Atomic Industrial Forum.[1] They point out that the various construction operations involved in site preparation and plant construction constitute non-point sources of various types and amounts of air, land, and water pollutants. The various phases of power plant construction include the following: pre-construction activities, site work, permanent facilities construction, and project close-out. The primary measures to be employed during earth work include control of storm water

[1] Atomic Industrial Forum, "General Environmental Guidelines for Evaluating and Reporting the Effects of Nuclear Power Plant Site Preparation, Plant and Transmission Facilities Construction", February 1974.

drainage, soil erosion by water and wind, downstream damages from sediment and increased stream flow volumes. Perhaps the most serious impact of site work on water resources are the effects of dewatering on the groundwater supply, and on adjacent wetlands or other vulnerable aquatic ecosystems. Any of the pre-construction and construction impacts inherent in power plant preparation may also be relevant to transmission corridor construction. Frequent irretrievable commitments of resources resulting from these types of construction include impairment of the natural physical environment, such as the loss of wildlife habitat; destruction of nesting, breeding or nursing areas; interference with migratory patterns; loss of valuable or aesthetically valued areas; and the expenditure of directly utilized land, water, and building resources.[1] In order to reduce the total impact, Hittman Associates suggests proper power plant site location and general protective measures including the following: seasonal timing of construction activities to avoid mass clearing and grading operations during seasons of the year when heavy rainfalls can be expected; staging of construction operations and activities so that all clearing, grading, and stabilizing operations are done in each area before moving on to another; utilization of vegetative filter strips, contour strips, and uncleared portions of stage development projects to filter sediment and nutrients; exposed soil stabilization, including seeding, mulching; sediment basins and diversion structures to contain run-off and sediment; and streambank and shoreline protection measures, including maintenance of original vegetation and possibly regrading and immediate revegetation.[2]

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[1] Atomic Industrial Forum, "General Environmental Guidelines for Evaluating and Reporting the Effects of Nuclear Power Plant Site Preparation, Plant and Transmission Facilities Construction", February 1974, p. 47.

[2] Ibid., D 1-20.

Environmental Impact Assessment--Tools and Methods

Accurate environmental impact assessment is a critical phase of predicting the consequences of power plant construction and operation. According to Dr. Andrews, two principal tasks of an impact assessor are to "identify what functions of the affected resources would be modified by each alternative proposal and to predict reliably the directions and magnitudes of the modifications likely to result from each alternative".[1] Historically, many impact assessors have gathered voluminous amounts of information and data on a wide spectrum of potential areas of environmental impact. However, if environmental impact assessment is to serve the needs of decision makers, it must gather information selectively and clarify impacts on valued resources and natural resource systems rather than accumulating vast bodies of empirical data. This large collection of empirical data often does not serve to facilitate sound decision making.

There are a great many problems inherent in environmental impact assessment. Perhaps the foremost of these problems is the significant degree of uncertainty and a lack of knowledge of what many of the inter-relationships are in the natural systems that may be impacted. Several of the reasons for this uncertainty are a general lack of knowledge, areas in which impacts are only probabilistic in nature, and others, such as the continued exposure to low level radiation, the accumulative effects of which are simply not known. A second significant problem encountered in impact assessment is deciding which alternatives and impacts should be studied and in what detail. This is an area in which the multi-disciplinary impact assessment team can be of great assistance in delineating the critical

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[1] Andrews, Richard N. L., "A Philosophy of Environmental Impact Assessment", 1973, p. 198.

potential impacts of the various alternatives. Costs and time are always critical factors in deciding the amount of detail that is feasible and attainable.

Environmental impact assessment is a very sophisticated task, requiring a great deal of professional skill, scientific knowledge, and predictive insight. Many of the environmental impact assessment methodologies developed in recent years have not reflected the required degree of sophistication to ascertain accurately the consequences of developments or actions impinging on the natural environment. It is imperative that impact assessment clarify the consequences of public decisions. This process should communicate, unequivocally, the implications of choosing one action over another, with respect to all competing users of the resource systems affected. It is important that the process be an on-going one, continuing from the initial definition of a planning problem, through the entire course of implementing the project or program. Without this continual cognizance of environmental impacts and modifying projects and programs accordingly, impact assessment is "at worst a paperwork problem, and at best an expensive subsidy for consultants".[1]

With the tremendous proliferation of environmental impact assessment methodologies, it has become increasingly necessary to review and critique these methods. One of these reviews of impact assessment methods has been conducted by contract with the Environmental Protection Agency.[2] This review divides the various methodologies into five types, based on the way impacts

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[1] Andrews, Richard N. L., "A Philosophy of Environmental Impact Assessment", 1973, p. 203.

[2] Warner, et. al., "A Review of Environmental Impact Assessment Methodologies", April 1974.

are identified. These classifications are:

1. Ad hoc--These methods provide a rather superficial guidance to impact assessment, merely delineating broad areas of possible impacts.

2. overlays--This is the McHargian approach, in which a set of maps of environmental characteristics are prepared for the project area and then overlayed to produce a composite characterization of the regional environment.

3. checklists--These methods present a specific list of environmental parameters to be analyzed for possible impacts, but often do not require the establishment of direct cause and effect linkages.

4. matrices--This method incorporates a list of project activities in addition to the checklist of potential impacts and links the two together in a matrix, which alleges to identify cause and effect relationships.

5. networks--This type of assessment method deals with a list of project activities to establish cause-condition-effect networks. This is designed to identify a series of impacts, which may be triggered by a particular project action.

The Water Resources Council, with the establishment of their Principles and Standards for Planning of Water and Related Land Resources, have attempted to establish a type of environmental impact assessment. These Principles and Standards require, for each alternative plan, that a complete display or accounting of the relevant beneficial and adverse effects on the national economic development and environmental quality will be prepared. The beneficial and adverse effects are to be measured in either monetary or non-monetary terms. These accounts are established in order to measure and display in appropriate terms the net changes or potential impacts, with respect to the two objectives, that are generated by the alternative plans.[1]

In order to accurately assess environmental impacts and predict consequences of these impacts, a great deal of data is required. Collecting this data requires a combination of various tools available to the impact assessor.

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[1]Volume 38 of the Federal Register, Monday, December 10, 1973.

The use of aerial photographs is a very important tool for obtaining a significant amount of physiographic, geologic, soils, vegetation, water resources, and ecological habitat information. A skilled aerial photo interpretor can derive a great deal of valuable information from black and white photographs. For a thorough discussion of this tool for impact assessment, see Terrain Analysis by Douglas S. Way.[1] Similar types of data and information on a much larger scale can be derived from remote sensing photographs such as those derived from the ERTS satellite, the Skylab operation, and the high altitude RB 57 aircraft.[2] The principal advantage of this remote sensing is that it utilizes a multi-spectoral scanner which differentiates between bands of various radiation, and allows a more detailed analysis of land forms and water resources. In addition, the thermal band contained on the Skylab and the RB 57, as well as the lower altitude sensing devices, greatly facilitates data collection and environmental impact assessment relevant to power plant discharges and thermal analyses.[3]

The use of modeling in impact assessment has increased greatly in recent years. Both mathematical modeling and hydraulic modeling or scale modeling have been utilized to predict the consequences of particular developments on the natural resources systems. Scale modeling is much more accurate for ascertaining potential impacts on small scale developments. However, these hydraulic models are usually quite expensive and do not always

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[1] Dowden, Hutchinson, and Ross, Inc., 1973.

[2] Personal communication, Fabian Polcyn, ERIM, July 18, 1974.

[3] Sollars, Scott C. "Nature's Dynamics: An Elevated Perspective", 1973.

accurately represent the natural systems. It should also be noted that they are primarily limited to physical parameters and cannot accurately represent biological systems. Mathematical modeling, on the other hand, is used to simulate both the physical and biological processes.[1] However, the predictive capabilities of this type of modeling are greatly curtailed when adequate data is not available to verify the model. Also, the state of the art for biological modeling, and particularly ecological systems modeling, is very primitive.[2] However, both these types of modeling are valuable tools to utilize for environmental impact assessment.

The environmental impact assessor should realize that there are a wide variety of potential tools for data collection. Aerial photography and remote sensing data collection are valuable methods. But on-site inspection and detailed field work are often required to verify results derived from photographs. It is also axiomatic that field work must be conducted to accurately assess biological communities, ecological relationships, such as species diversity and abundance, and critical breeding and resting areas for a wide variety of aquatic species. It is, therefore, imperative to utilize field work, sometimes laboratory analysis, aerial photography and remote sensing, and mathematical and scale modeling, to accurately determine and predict environmental consequences of proposed actions.

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[1] Hydroscience, Inc., Limnological Systems Analysis of the Great Lakes, March 1973.

[2] Personal communication, William Cooper, Professor--Michigan State University, October 10, 1974.

CHAPTER FOUR

MINIMIZING ENVIRONMENTAL IMPACTS THROUGH PROPER POWER PLANT SITING

In addition to energy conservation measures, which would reduce the total amount of electrical energy consumption, intelligent power plant siting policies represent another alternative for minimizing environmental damage. A generalized site selection criteria should include a thorough analysis of the following parameters: electric power demands and load center identification; seismic, geological, and soil stability characteristics; dispersion climatology; hydrologic characteristics; ecological dimensions, including prime breeding areas, species migration, and temperature-sensitive aquatic species; surrounding land use patterns and population density; unique natural resource areas and important historical or archaeological sites; and aesthetic considerations, including transmission corridors and the actual power plant site. Proper location of a power plant represents an extremely complex problem and requires an extensive environmental analysis and inventory of various processes and resources within the coastal zone. The construction and operation of a power plant facility is essentially a short to moderate term (30 to 40 years) irreversible commitment of capital, land, and natural resources.[1] The improper location of a power plant may result in disastrous environmental impacts, such as increased air pollution, inadequate dissipation of thermal effluents, severe depletion of planktonic species and fish larvae, and in the case of nuclear power production, continuous exposure to low level radiation. For these reasons, it is imperative that

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[1] Fisher and Krutilla, "Valuing Long-Run Ecological Consequences and Irreversibilities", 1974, p. 98.

power plants not be located in wetlands, estuarine areas, and other areas of critical environmental importance, such as prime breeding grounds or waterfowl sanctuaries.

Specific power plant siting criteria may be found in several sources. The following criteria were prepared by Battelle Memorial Institute, Columbus Laboratories, for utilization by the Atomic Energy Commission. Their recommended criteria include:[1]

1. General seismic and geological characteristics--adequate information on seismic and geological characteristics of a proposed site should be available in order to provide a reasonable degree of assurance that the plant can be constructed and operated without suffering damage that will have adverse impact upon the environment.

2. Soil stability and topography--preferred sites for power plant location are in areas with good soil stability, adequate drainage and limited topographic relief, and in areas where there is no danger of subsurface subsidence.

3. Floods and waterwaves--power plants should be located in areas where they are removed from danger resulting from storm induced waves, flooding, severe shoreline erosion, or on the Great Lakes, increased water levels due to precipitation or barometrically induced seiches.

4. Climatological dispersion--a proposed site should provide adequate atmospheric dispersion of low level radioactive emissions, waste heat, and various air pollutants, sufficient to protect the surrounding environment from degradation.

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[1]Battelle Memorial Institute, General Environmental Siting Guides for Nuclear Power Plants, Draft, December 1973.

5. Atmospheric dispersion--shoreline sites, proposed sites should be located in areas where maximum mixing and dissipation of thermal effluents can occur.

6. Fogging and icing--power plant sites which would utilize cooling towers, cooling ponds, or spray canals should not be located in areas which would result in unacceptable fogging and icing.

7. Adequate water supply--an adequate water supply must be available to provide for continued plant operation over the design life of the facility. Presumably, any site along the Great Lakes shoreline would satisfy this requirement. Utilization of groundwater reserves is not generally recommended for thermal power cooling due to the dangers of exceeding the natural recharge rate of the aquifer and, therefore, causing a lowering of the regional water table.

8. Stratified water bodies--water bodies or areas within the littoral zone which are stratified at any time of the year need special consideration for their vertical mixing characteristics in order to maintain efficient cooling capacity while not exceeding the thermal assimilative capacity.

9. Ecological parameters--power plants should not be located in critical environmental areas where the effects of entrainment or thermal dissipation may have deleterious impacts on the populations. Areas specifically to be precluded from siting of power plants include prime estuarine and wetland breeding habitats, species migration areas for anadromous spawning species, or waterfowl resting or breeding grounds.

10. Land use dimensions--the proposed site should be in an area in which the plant will be compatible with existing land uses. Specific consideration should be given to possible secondary increases in development due to the operation of the power plant.

11. Human interest factors--unique natural resource areas, historical areas, archaeological sites, and important fossil and rock deposits should be avoided when siting power plants.

12. Aesthetic considerations--special architectural design and landscape screening or placement should be considered in relation to both power plants and transmission corridors to minimize the impact on the aesthetic quality of the environment.

The Atomic Energy Commission has recently released draft site suitability criteria for nuclear power stations.[1] These proposed criteria are substantially the same as those formulated by Battelle, but include a more extensive section on social and economic impacts similar to those discussed in Chapter Three. The AEC proposed regulations also emphasize the issue of population density surrounding a proposed nuclear power station and state, "As set forth in 10 CFR Part 100, a nuclear power plant site must have a low population zone immediately surrounding the exclusion area in which the population is sufficiently limited in number and distributed in such a way that there is a reasonable probability that appropriate measures could be taken in their behalf in the event of a serious accident."[2] The AEC regulatory staff has found that a minimum exclusion distance of 0.4 mile usually provides assurances that engineered safety features can be designed to allow only "reasonable" emissions of low level radioactive particles. In addition to the regulations proposed by the AEC, the Federal Power Commission has released general environmental impact criteria for hydro-electric and pumped storage facilities.[3] The FPC variables are very similar

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[1] U.S. Atomic Energy Commission, Regulatory Guide 4.7 Draft, September 1974.

[2] Ibid., p. 4.7-7.

[3] Federal Power Commission, Order No. 485, June 7, 1973.

to those included in the AEC guidelines.

John Clark has proposed the following as recommended constraints to power plant siting:[1]

"1. Wetlands, and other vital areas are inappropriate sites for power plants.

2. Open cycle cooling is acceptable only for open coast or offshore Great Lakes and ocean sites, away from areas of environmental concern, and then only if appropriate safeguards are employed in the design of cooling water systems and the location of intakes and outlets.

3. Closed-cycle cooling is required for all power plants located on or adjacent to estuaries, bays, lagoons, and other areas of environmental concern.

4. Power plants are not to be located on or adjacent to vital areas regardless of cooling system--and these areas are to be delineated in biotic surveys and set aside as zones of exclusion for power plants and other installations with a similar potential for environmental disturbance."

In addition to the proper location of power plants, Clark further acknowledges that the proper design of cooling systems to minimize entrainment and impingment of aquatic organisms on intake structures, and power plant operating strategies, including the elimination of chlorine as a fouling agent, utilizing instead mechanical devices or back flushing of thermally heated water to kill undesirable species or organisms, would serve to significantly minimize adverse environmental impacts of power plant operation.[2]

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[1] Clark, John, Coastal Ecosystems, 1974, p. 140, 141.

[2] Clark, John, Electric Power Plants in the Coastal Zone: Environmental Issues, p. VIII-1.

An interesting power plant siting option for Lake Erie has been proposed by Dr. Richard A. Cole, Michigan State University. He suggests that in view of the shallow and gentle bottom slopes of Lake Erie, the potential exists for building cooling ponds into the lakes. Dikes could be constructed around many of the power plant sites so that a cooling pond is created which would result in a potential increase of shoreland values. The cooling pond construction could possibly be utilized for public recreational purposes, marsh development which could be used by water fowl and other marsh species, and of course, a reduction of thermal dissipation into the open lake.[1] Dr. Cole asserts that management of heated discharges with cooling ponds would "protect the environment much more effectively than cooling towers which require more makeup water, kill everything that enters the cooling system, requires more additives (biocides, anti-scale), and may locally degrade some aquatic resources and cause more local fogging and cooling".[2]

Offshore Power Plant Siting

Offshore siting of nuclear power plants has been proposed as an alternative which allegedly would alleviate concerns about the environmental impacts of power plants. Another potential advantage of offshore siting of power plants is the capability to locate the power plant close to the load centers, but not directly within densely populated areas. Two types of offshore power plants are the floating nuclear power plant and the artificial island concept. According to Joseph Stadelman, vice-president of Offshore Power Systems, "The floating nuclear power plant offers a siting flexibility which is new and unique."[3] Water depths of about 40 to 50 feet are required for offshore siting

[1] Cole, Richard A., Environmental Changes in Lake Erie and Their Future Impacts on Lake Resources, 1973, p. 74, 75.

[2] Ibid., p. 75.

[3] Stadelman, Joseph, "Floating Nuclear Power Plants, A Case in Point", September 1974, p. 64.

of nuclear power plants. The marine coastline appears to be more condusive for offshore power plant siting due to the presence of tides which would be used to dissipate the thermal discharges. The Atomic Energy Commission has conducted studies to determine the engineering feasibility and safety of floating nuclear power plants, and apparently endorse the concept.[1]

While the offshore power plant siting concept appears to have some advantages, it also has some rather significant disadvantages. Impacts of extensive dredging and filling activities, damages resulting from storms or ships colliding with the facility, and the hazards of transporting radioactive materials both to and from the offshore facility are important considerations. As in the case of improperly located shoreline power plants, offshore siting could result in significant impacts due to entrainment or thermal discharges. Therefore, offshore siting of power plants should not be considered a panacea for resolving the siting dilemna.

Presently, it appears that offshore power plant siting, especially for the Great Lakes region, will not become a reality in the near future. The leading proponent of offshore power plant siting, Offshore Power Systems, has recently announced that it is postponing for three years its production of floating nuclear power plants. Offshore Power Systems is located in Jacksonville, Florida, and is jointly owned by Westinghouse Electric Corporation and Teneco, Incorporated. The firm cited a breakdown in negotiations and the current economic climate as the explanation for the delay. The delivery date for the first floating power plant is now anticipated to be May 1985.[2] It is unlikely that a floating nuclear power plant could be delivered to the Great

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[1] Atomic Energy Commission, A Survey of Unique Technical Features of the Floating Nuclear Power Plant Concept, March 1974.

[2] Coastal Zone Management Newsletter, December 4, 1974, p. 2.

Lakes region until a much later date, if ever. The restrictions of the St. Lawrence Seaway would make it virtually impossible to float a nuclear power plant into the Great Lakes, and it will be many years before a production plant would be located within the Great Lakes region.[1]

Transmission Corridors

Many of the land use, aesthetic, and construction impacts inherent in power plant siting are also relevant to transmission corridor planning. Here again, however, intelligent planning and locational policies can minimize adverse environmental impacts. Preservation of natural landscapes and minimizing conflict with present and planned land uses should be important criteria for the selection of transmission corridors. Power plant siting decisions should also consider the disturbances of land uses resulting from acquisition of land for transmission line corridors. In addition to these impacts, extra high voltage transmission lines frequently result in several electrical environmental effects. These may include radio and television interference, audible noise resulting in noise pollution, induced voltages on ground objects which may result in impairment of public safety and comfort, and increased quantities of ozone which may affect the ambient air quality.

Transmission line corridor selection criteria should include the following dimensions: impacts on natural ecosystems resulting from construction processes and permanent installation of transmission facilities should be minimized; areas of population concentration and intense activity should be avoided; future land uses should be considered and areas of future population concentration and intense activities should be avoided; areas of important aesthetic or cultural values should be avoided; and, where possible, existing

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[1]Personal communication, Dr. Steven Long, Maryland Power Siting Commission, December 18, 1974.

and proposed rights-of-way should be utilized. The visual impacts of transmission corridors can be minimized through a variety of techniques. Selection of colors for structures which blend in with the natural landscape tend to minimize visual impact. Visual screening, through the use of natural vegetation or topographical features such as ridges, can also minimize aesthetic impact.[1] Technology is developing rapidly which utilize compressed gasses as an insulation medium, thereby enabling underground transmission lines to become a reality.[2] Another alternative which deserves more attention is the usage of common rights-of-way for utility corridors, which could include power, water, gas, and telephone lines. Transmission corridors may also be used for recreational activities such as cross country skiing and hiking.[3] This recreational potential of transmission corridors should definitely be analyzed further, and may represent a "true multiple use" approach to natural resources management.

Land Capability Analysis

A potentially far-reaching concept implicit in this discussion of power plant siting criteria is a fundamental change of attitude towards our environment. We must accept that the environment has its own inherent laws which present intrinsic opportunities and constraints to human use. It is all too clear that man cannot continue to manipulate natural systems in a detrimental manner without suffering dire consequences. While this

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[1] National Academy of Engineering, Engineering for a Resolution of the Energy-Environment Dilemma 1972, p. 258.

[2] Ibid., p. 252.

[3] Stewart, Ronald, "Helping Power to be a Good Neighbor", N.O.A.A., April 1974, p. 18.

fundamental attitude change is primarily a philosophical one, it can be translated into policy measures to serve as useful tools for implementing desired programs. One approach to this environmental planning involves analyzing the land to ascertain its potential for economic development. The tool that is employed for this purpose is similar to Ian McHarg's concept of physiographic determinism.[1] The natural processes that are examined include: topography and subsurface geology, surface and groundwater, climatic and hydrologic relationships, floodplains, soils, and vegetation. A set of physiographic principles are then formulated. The principles indicate the categories of development and densities that are environmentally acceptable.

Examples of these principles are: essential agricultural lands should be preserved; development should be prohibited over prime aquifer recharge areas; 100-year floodplains should be exempted from all development, save agriculture and recreation; and slopes of 25% or greater should be prohibited for development. Utilizing a natural systems approach to planning facilitates rational and intelligent guidance of development. Development in consonance with physiographic opportunities and liabilities allows the preservation of valuable natural systems and the enhancement of the quality of life by accommodating required development while ensuring the highest level of amenity. The State of Ohio Department of Natural Resources is currently utilizing this land capability analysis in conjunction with sophisticated computer programming to formulate county land use plans, develop wild and scenic river corridor plans, and analyze the Lake Erie coastal zone.[2]

A second approach to environmental planning involves ecological systems analysis to determine regional tolerances for development. Ecological analysis

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[1] McHarg, Ian, Design With Nature, 1970, p. 81.

[2] Ohio Department of Natural Resources, Lake County Land Capability Analysis, October 1974.

considers: biological communities; ecological irreversibilities; ecological potentialities for production and assimilation capacities; fragile systems such as estuaries and shorelines; and energy and materials costs and flows.[1] John Clark utilizes this ecological systems analysis to categorize coastal zones into either preservation areas which should not be developed, development areas which are comparatively suitable for development, and conservation areas which serve as buffer areas between the preserved and developed areas.[2] Ecologist Eugene Odum has proposed four landscape compartments: the productive compartment, which is composed of agricultural or managed forest lands; the protective compartment, which contains those areas which serve a vital function in environmental protection; the urban-industrial compartment, which includes land already intensively developed or best suited for such development; and the compromise or multiple use compartment, which includes all lands not falling exclusively into one of the other compartments and which can serve several uses simultaneously. These various approaches are certainly not the only way of dividing up the landscape, but serve as a reasonable and useful framework for ecological land use planning.

The goals and objectives of the ecological approach to land use planning are basically the same as those of the physiographic method. The ecological approach accommodates economic development goals while maintaining valuable ecological systems and processes. In both cases, however, the overall guiding criteria is that man must learn to live with nature and conform to certain immutable environmental laws.

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[1]Cooper, William and Vlasin, Raymond, "Ecological Concepts and Applications to Planning", 1973, p. 200.

[2]Clark, John, Coastal Ecosystems, 1974, p. 91.

CHAPTER FIVE

POWER PLANT SITE AND TRANSMISSION CORRIDOR SELECTION METHODOLOGY

Selection of a preferred power plant site or transmission corridor from a wide array of alternative choices is a complex and difficult process. Public and private utilities, consulting firms, and State agencies are all involved in this site and corridor identification, inventory, and selection process. This chapter will briefly analyze three methods for selecting preferred sites that have a number of similarities and differences. However, each is essentially a selective screening process.

The Utilities' Selection Process

Historically, utilities based site selection primarily on engineering and economic factors. Subsequent to the passage of a National Environmental Policy Act, the utilities were compelled to include environmental concerns in their selection studies. Due to the long lead times required for major power plant construction, many utilities had heavy financial commitments to sites selected prior to the passage of NEPA. Many initial environmental reports were "backfit" additions to the previous economic and engineering siting studies. Most utilities realize today that the success or failure of the licensing process for a proposed new facility is greatly influenced by the quality of the initial siting study; and therefore, utilities are amenable to spending a great deal of money for this work. Utilities may conduct "in-house" siting studies, or may rely on private consulting forms for accomplishing this work.

Many of the larger utilities have extensive "in-house" capabilities for environmental studies and siting analyses. Consumers Power Company, one of two major utilities in the State of Michigan, has both an environmental section and a power plant siting section. During the past two years Consumers Power has completed an extensive analysis and inventory of potential power plant sites, both inland and within the coastal zones. Consumers Power

Company utilized the services of Commonwealth Associates, a consulting firm, for an initial assessment of potential sites and then completed the siting inventory with their own staff. This siting inventory involved 140 potential sites which were eventually narrowed down to 14 which may be purchased.[1] This particular site inventory was a continuous screening process which took place over a number of years and involved increasing levels of detailed analysis. Potential sites were initially identified on a map on the basis of water availability and projected load centers. Many of these sites were then either flown over or driven by to observe any obvious impediments to site development. The most desirable of these sites were then field surveyed to ascertain construction and environmental capabilities.[2] This siting inventory, as are most utility's siting studies, was carried out in confidence. The utilities seek to avoid an escalation of land prices, possible speculation, and full public exposure of sites before engineering and environmental issues are fully evaluated.

Commonwealth Associates have recently completed a study for the Atomic Industrial Forum which analyzes the general siting procedures frequently utilized by utilities.[3] This generalized process involves an iterative evaluation of potential areas with each additional evaluation increasing in detail. The initial area of evaluation is the region of interest which usually represents the total service territory for the utility. Candidate areas within the region of interest are then investigated for potential sites. Potential sites

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[1] Personal communication, Robert Gerzetich, Consumers Power Company, December 18, 1974.

[2] Ibid.

[3] Commonwealth Associates, Inc., Nuclear Power Plant Siting--a Generalized Process, August 1974.

are then identified within the candidate areas for preliminary evaluation leading to the designation of candidate sites. Candidate sites are suitable for evaluation as alternatives in the selection of the proposed site. The proposed site is that site identified in the license application.[1] The factors involved in the increasingly detailed evaluation include: systems planning, safety, engineering, environmental, institutional, and economic dimensions. In the early stages of siting evaluation, an acceptability/exclusion screening process may be utilized to eliminate undesirable sites. Cooling water availability, suitable accessability to transportation routes, population density, or conflicting land uses are common screening considerations. The remaining sites may be successively screened, comparatively evaluated, or classified and numerically rated. At this stage, the comparative cost analysis and balancing of costs and environmental impacts are extremely important and formalized numerical rating systems may be utilized to ascertain which sites is the most desirable.[2] The Commonwealth Associates' study concludes:[3]

> "In the final analysis, there is no one method for site selection and evaluation which can be considered superior to the others or which can represent a single standard method for nuclear power plant site selection. The considerations involved in evaluating sites are diverse and complex. Each siting regimen must evolve based upon the characteristics of the area, characteristics of the utility, and stage of the siting process. It must be recognized that the nuclear power plant site selection and evaluation is an evolving process involving a relatively new source of energy for power production. Accordingly, the need for continued study and updating of these techniques is considered desirable as industry and government strive to achieve a common goal of acceptable and timely sites for nuclear power plants."

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[1] Commonwealth Associates, Inc., Nuclear Power Plant Siting--a Generalized Process, August 1974.

[2] Ibid., p. 44.

[3] Ibid., p. 4.

A Consulting Firm Approach to Site Selection

Commonwealth Associates, located in Jackson, Michigan, has been involved in power plant siting and transmission corridor studies for many years. In addition to innovative environmental impact assessment methodologies, Commonwealth's formalized numerical rating methods are a significant contribution to facility siting technology. These techniques are essentially a structured-quantitative analysis of a number of highly diverse considerations. Commonwealth has also developed what it calls its "ENVIRO" family of computer programs which provide a sensitivity analysis of the most significant impacts, as well as great flexibility in the ability to analyze a number of sites and a variety of impacts. The numerical rating method and sensitivity analysis are extremely useful in the final selection of a proposed site from a number of candidate sites.

Sophisticated computer programming, in addition to numerical rating techniques, are used to develop a composite rating of total impact. It should be recognized that all specific impacts are not equally important and, therefore, the assignment of importance weights is a very crucial determination. It is possible, by varying the importance weights on alternative impacts, to represent different perspectives and develop an array of alternative decisions. This alternative weighting system and sensitivity analysis is a valuable analytical tool for decision making among groups with divergent opinions.[1]

In addition to its usefulness for power plant siting decision making, sensitivity analysis and computer mapping are extremely valuable tools for identifying alternative transmission corridors. In a study completed for

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[1]Personal communication, Halden Smith, Commonwealth Associates, Inc., December 18, 1974.

Consumers Power Company, Commonwealth Associates identified environmentally suitable transmission routes to connect the Millington and Blackfoot substations in Michigan. The following five basic objectives were established to guide the analysis of the proposed transmission route: protection of natural systems; compatibility with existing land uses; evaluation of proposed land uses and population densities; impacts upon culturally significant areas; and the opportunity for right-of-way sharing. A multi-disciplinary team of investigators was utilized to collect relevant information. Computers were then utilized to translate the information into computer maps which were utilized to identify alternative transmission corridors. A reasonably objective analysis, including numerical rating and computer sensitivity analysis, is then combined with information from those who live or work in the area and State, regional, and local governmental officials to finalize the selection of an acceptable corridor.

Sophisticated computer analysis is a tremendous tool for power plant site selection and transmission corridor location. But this tool is extremely expensive and accentuates the need for physical, ecological, and land use data and information. Information such as high resolution aerial photographs, topographic and existing land use maps, community comprehensive development plans, soil surveys, and field surveys are required for site selection and corridor location. Site selection and corridor location require, as in the case of environmental impact assessment (discussed in Chapter Three), a combination of analytical tools and utilization of a variety of data and information sources.

New York State Site Survey

This past summer, the Office of Environmental Planning of the New York Department of Public Service completed a twelve county pilot site survey. The main purpose of the study was to locate sites for thermal

power plants which can be developed with little apparent likelihood of environmental damage, at an acceptable cost. The first step in the survey is a land use screen. The New York State Land Use and Natural Resources Inventory, LUNR, which is a computerized land use inventory composed of one square kilometer cells throughout the state, was used for the screening process. A computer program was utilized to eliminate cells containing land uses which were judged to be incompatible with power plant development or in which 75% or more of the area was covered by surface water. Cells that survived the land use screen were then analyzed for slope. All cells having slopes of 10% or greater covering 70% or more of their total area were eliminated from further consideration. The remaining cells were inspected in the field for incompatible topographical features or land uses that had developed since the collection of data for the LUNR Inventory.[1]

The cells that survived the field check were given a terrestrial ecology uniqueness rating. This rating considered the number and extent of different habitats and the ecological value and scarcity of the habitats. These remaining cells were also given an aquatic vulnerability rating. This vulnerability rating included potential disruptions that could result from generating facility construction and operation. Larger areas were evaluted for air quality and meteorological conditions which reflected extrapolated levels of NO, SO_2 and particulates, as well as the topography and extrapolated inversion potential. The cells that survived the field check were also evaluated to determine the incremental cost and environmental impacts of four cooling

[1]New York State Public Service Commission, Draft Report on the Hudson River Valley/Long Island Pilot Area Site Survey, July 1, 1974, p. 3.

alternatives. In the final analysis and rating, the terrestrial ecology, aquatic ecology, and water quality and hydrology scores of the cells were converted to a common scale and summed to produce a composite score. One-hundred and twelve cells were identified as potential locations for power generating facilities.[1]

The New York State Power Plant Site Survey is intended to provide assistance to electric utilities in their search for environmentally sound plant sites. The survey, when completed, will encompass nearly the entire area of the state and will have identified a large number of potential sites throughout the state upon which steam electric generating facilities could be located with minimal environmental damage. In the future, many of the potential sites will be further evaluated for specific environmental and engineering compatibility. According to the survey report,[2]

> "The site survey is not intended to be a substitute for the environmental impact studies required by Article VIII of the Public Service Law. The purpose of the survey is to identify a number of promising sites which deserve more intensive examination. The survey systematically applied a number of carefully chosen criteria to a very large number of possible sites. There is no guarantee that a detailed study of a particular site may not reveal characteristics not identified using this survey methodology."

The New York State Site Survey represents an extensive effort to identify potential power plant sites. This information, in combination with sites identified by public utilities, consulting firms, and other state agencies, represents a wealth of information pertaining to site selection.

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[1] New York State Public Service Commission, Draft Report on the Hudson River Valley/Long Island Pilot Area Site Survey, July 1, 1974, p. 6.

[2] Ibid., p. 9.

The need for cooperation and coordination among the various governmental and private entities concerned with site selection and corridor location cannot be sufficiently emphasized. Federal, State, and local governmental agencies, the utilities, university researchers, and the general public are all important resources that should be included in information collection and site selection procedures.

ENERGY FACILITIES SITING

INFORMATION PACKAGE

#1

JUNE 30, 1975

prepared by

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(*) Denotes items which have been sent to CZM State Contacts and are available for review in their offices.

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* 7. Geotechnical Consideration of Site Selection for an Offshore Nuclear Power Plant. Joseph A. Fisher, M. Kihnemuyi, and H. Singh. 1973 Offshore Technology Conference. Preprints Vol. 1. (p. 673-675).

8. Prespectives on Oil Refineries and Offshore Unloading Facilities. Proceedings of the Fourth New England Coastal Zone Management Conference. May 13-14, 1974.

9. Minutes and Summary of the First Meeting of the Advisory Committee on Energy Facilities Siting, Office of the Science Advisor, National Science Foundation, Washington, D.C. 1974.

CHAPTER SIX

STATE POWER PLANT SITING POLICIES

State Siting Policies in General

In the past several years, power plant siting has become an increasingly important issue for state legislation. As of September 1974, 18 states had passed power siting legislation and a significant number will consider such policies during their 1975 legislative sessions. According to Reitz, "regulation by states of power plant siting or placement of transmission lines is far from uniform, and is in a condition of flux, as states continually add or amend regulation systems or initiate them."[1] Many states have realized that the location of energy facilities influences the location of industrial complexes and urban expansion, and therefore, power plant siting policies become a key element in land use planning. In general, state power siting policies can be categorized into either reactive processes or preview processes. The New England River Basins Commission defines the reactive process as "a process when a state council or board must act upon an application for construction of a particular power plant without a formal process for advance consideration of utility long range plans or suitable sites".[2] The preview process requires advance analysis of public need for power and environmental evaluation of proposed sites prior to property acquisition.

Several factors apparently enter into a state's decision to either establish a separate power plant siting program, or include this as part of a more encompassing management program. According to Bradley and Armstrong, these factors include: "the immediacy of the threat of damage from unregulated location of power plants, the likelihood of passing more comprehensive management

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[1]Reitz, Arnold, Environmental Planning: Law of Land and Resources, 1974, p. 15-4.

[2]New England River Basins Commission, Draft Report on Power Siting Siting Legislation, August 1974, p. 11.

legislation, the desirability of focusing on power production as a particularly high impact industry, and the type of regulatory program established by the passage of the legislation at the Federal level."[1] The factors to be included in a power plant siting program, as defined by Bradley and Armstrong, include:[2]

> "an intensive procedure for mandatory review of potential sites; an adequate research program to investigate the environmental, general land use, and social factors involved; a method of sufficient funding; explicit guidelines safeguarding environmental and social interests upon which decisions for approval are to be made; provision for review of these decisions when necessary; sufficient staff to administrate the program; and procedures for enforcement of the provisions of the program."

It has also been suggested that if siting control is vested in a state level agency, that agency, in general, should not be the existing state-public utility commission.[3] The contention here is that an agency charged with insuring reliability and a continuity of service has a built-in bias which may tend to favor reliability over environmental protection.

A key feature of successful state power siting legislation is the simplification of various permitting and licencing procedures. This so-called "one-stop" licensing procedure requires coordination of agency review and delegates the final decision authority to one agency. According to a public utility executive, "It is absolutely imperative that this agency have the authority to overrule other state agencies and the state procedure must be compatible with the Atomic Energy Commission licensing regulations.[4]

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[1] Bradley, Earl and Armstrong, John, A Description and Analysis of the Coastal Zone and Shoreland Management Programs in the United States, March 1972, p. 49.

[2] Ibid., p. 49.

[3] Mitnick, Barry and Weiss, Charles, "The Siting Impasse and a Rational Choice Model of Regulatory Behavior: An Agency for Power Plant Siting", 1974.

[4] Personal communication, Robert Gerzetich, Consumers Power Company, December 18, 1974.

The licensing process would be greatly simplified if state licensing decisions were final, or at least the process involved the relevant Federal agencies so as to reduce or eliminate redundancy in the review process.

The Maryland Siting Process

While power plant siting legislation has been enacted in several states, the State of Maryland has perhaps the most aggressive power plant siting program. The Maryland Power Plant Siting Act of 1971 directs the Maryland Public Service Commission and the electric utilities to engage in long-range power systems planning. The Act also directs the Department of Natural Resources to prepare environmental statements on proposed power plant sites and to maintain a reservoir of state-owned sites which are environmentally suitable for power plant construction. The Act also directs the Maryland Public Service Commission to conduct extensive environmental studies, as well as a comprehensive research and monitoring program.[1] The authority to conduct siting inventories and acquire desirable sites presents the opportunity to assess potential environmental impacts and to direct the construction of power plants into areas which can best tolerate the additional stress, and which can assimilate the development and operational pressures with the least environmental damage.

The long-range plans and forecasts developed by the Public Service Commission and electric utilities must include proposed power plant sites

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[1] Southern Interstate Nuclear Board, Power Plant Siting in the United States, September 1974, p. 145.

for at least a ten year period. Following an environmental evaluation, the state is empowered to acquire and hold proposed sites until the utilities either purchase or lease the site. The utilities have the option of choosing one of their own sites, provided that it meets the state's criteria, or may procure a site from the state.

In order to provide scientific and technical information relevant to impact assessment and siting decisions, the state is commited to a comprehensive research and monitoring program. Studies conducted under this program include the power plant air monitoring program, impact analysis of brackish cooling water, thermal and entrainment impact assessments, environmental and wetland mapping programs, plume dispersion studies and modeling, and the detailed site investigations for proposed power plant sites.[1]

The funds required to implement the various provisions of the law are provided by the Environmental Trust Fund, a revolving fund which is administered by the Secretary of Natural Resources. This money is obtained from a surcharge on electricity generated within the State of Maryland. At the beginning of January 1972, the rate was 0.1 mil per kilowatt hour generated. The surcharge can be raised slightly but cannot exceed 0.3 mil. In 1973, the 0.1 mil generated approximately $3 million.

The Power Plant Siting Law stipulates that a minimum of four and a maximum of eight potential power plants sites should be in the land bank inventory. The state is currently in the process of purchasing two sites and possibly a third for inclusion in their power plant site land bank.[2] Under Maryland's Power Plant Siting Act, the state has the power

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[1]Maryland Dept. of Natural Resources, Record of the Maryland Power Plant Siting Act, Volumes 1-4, 1972-1974.

[2]Personal communication, Steven Long, Maryland Power Siting Commission, December 18, 1974.

of eminent domain for site acquisition, and therefore, is required to pay fair market value. The power of eminent domain is a critical aspect of an overall power plant siting acquisition program. Frequently, once a site is designated as a desirable one, the land values will skyrocket and without the power of eminent domain, the state is forced to pay an exorbitant price.

After several years of experience, the Maryland power plant siting program is viewed as a success by many people. The utilities are very much in favor of the program because of its simplified one-stop licensing process and by utilizing state-owned sites, they avoid local zoning difficulties.[1] The licensing process is further coordinated by the involvement of Federal agencies. In the Douglas Point site proposal, the U.S. Atomic Energy Commission is reviewing sites simultaneously with the state and state and AEC officials have expressed support for joint Douglas Point proceedings, both to avoid duplication of effort and to provide a single forum for public hearings.[2] The Maryland power plant siting program apparently is a successful one and may serve as a model for other states to follow. Under the Maryland program, the state has a wider choice of sites and has accurate information on sites early in the planning procedures. The power companies also benefit by acquiring sites which have been thoroughly evaluated for siting feasibility.

Great Lakes States Power Plant Siting Policies

Presently, three of the eight Great Lakes States have power plant siting laws and several others have pending legislation. The main provisions of these laws are depicted in Table Three. None of the Great Lakes States' power plant siting laws are as comprehensive as Maryland's siting program. The Great Lakes

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[1] Personal communication, John Dorsey, Maryland Public Service Commission, October 12, 1974.

[2] Maryland Dept. of Natural Resources, Record of the Maryland Power Plant Siting Act, May 1974, p. 1.

States' siting programs and proposals will be briefly discussed in the following paragraphs.

Illinois - While the State of Illinois does not have a formal power plant siting law, utilities must obtain a certificate of public convenience and necessity from the Illinois Commerce Commission prior to construction of a new generating plant. The Illinois Environmental Protection Act of 1970 addresses the subject of power plants as potential sources of pollution. Although no specific state siting legislation has been introduced in recent years, increasing state-wide interest in power plant siting problems may lead to legislative proposals in the 1975 session. The Illinois State Atomic Energy Commission held hearings in 1974 on the siting of energy conversion facilities. Discussions centered around such factors as one stop certification, long-range planning, environmental considerations, and lead agency designation.[1]

A real issue in Illinois and especially along Lake Michigan, is not where to locate power plants, but whether the heavily urbanized and industrialized environment can tolerate the additional stress of power generation.[2] Considerations of ambient air and water quality and noise levels are paramount in this region. Consequently, there is a very real need for consideration of sharing power production between states. This situation highlights the need for regional power planning and coordination among Great Lakes states.

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[1] Southern Interstate Nuclear Board, Power Plant Siting in the United States, September 1974, p. 98.

[2] Personal communication, Ralph Fisher, Illinois Dept. of Conservation, December 15, 1974.

Indiana - The State of Indiana does not presently have a power plant siting law. In 1974, a bill was introduced into the General Assembly of Indiana which provided for one-stop siting approval for power facilities. The proposed measure would also have required every utility to prepare and file a ten-year plan with the Public Service Commission of Indiana.[1] This bill did not pass the legislature, but may be introduced during the 1975 session.

Michigan - Although the State of Michigan does not presently have a power plant siting law, several siting bills have been introduced in recent years. In 1971, a bill passed the Senate which would have required electric utility companies to obtain certificates of public convenience and necessity from the Public Service Commission, but this bill died in the House. Several siting bills were introduced in the 1974 legislative session. HB 5887 would have established a nine-member council within the Michigan Department of Commerce to regulate the location of power facilities within the state. The bill also would have required electric utilities to submit plans for proposed power plant sites and obtain certification from the council prior to site acquisition and development. Another bill, HB 6253, was proposed by the Michigan Public Service Commission. This bill would have granted the Michigan Public Service Commission the power to review plans, forecasts, and expansion of electric utilities and to regulate the location, construction, and operation of electric generating plants. Under this bill, the utilities would have to obtain a certificate of public convenience and necessity and environmental compatibility for proposed electric facilities. Neither bill passed during

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[1] Southern Interstate Nuclear Board, Power Plant Siting in the United States, 1974, p. 101.

the 1974 legislative session, but prospects for passage during the 1975 session appear to be better. The Public Service Commission has concluded that control of power plant siting by permit systems simply does not work, and therefore, they will continue to press for siting legislation.[1]

Minnesota - The Minnesota legislature created, in 1973, the Minnesota Environmental Quality Council. This Council has the authority to regulate siting of power plants and the location of transmission corridors. Utilizing long-range forecasts provided by the utilities, the Council intends to develop an inventory of power plant sites and transmission line corridors.[2] The criteria for siting power plants and routing transmission line corridors promulgated by the Council place a heavy emphasis on environmental considerations. The Council's regulation include a rather extensive exclusion criteria which prohibit power plants or transmission corridors from many parks and historical sites, wild and scenic river corridors, and state wilderness areas. Further, the site selection criteria contain many of the aspects discussed in Chapter Four of this paper. Public participation, including a number of advisory committees pertaining to siting and corridor evaluation is also emphasized in the regulations.

New York - Power plant siting programs in the State of New York began in 1968 when the Atomic and Space Development Authority was empowered to acquire and develop sites for future nuclear power plants. The Authority was not completely autonomous and did consult extensively with concerned state agencies. The Authority's control was limited to studies for nuclear power plants and thus excluded the question of sites for fossil

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[1] Personal communication, Ronald Callen, Michigan Public Service Commission, December 15, 1974.

[2] Southern Interstate Nuclear Board, Power Plant Siting in the United States, September 1974, p. 187.

fuel plants. Following a reorganization of environmental agencies in 1970, the Department of Environmental Conservation and the Public Service Commission were granted the major responsibility for power plant regulation. In 1972, the New York legislature passed power plant siting legislation. The Power Plant Siting Board, who's members include the Chairman of the Public Service Commission and the Commissioner of Environmental Conservation, are responsible for review and approval of proposed sites. Detailed environmental site review and facility description and long-range need justifications are part of the site application. The applicant is required to provide $25,000 to local government for expert advice. Utilities are required to submit ten-year plans for state review which include the number and types of facilities and anticipated research expenditures.[1]

The Department of Environmental Conservation is currently involved in the environmental review process for both siting of electric generation facilities and transmission facilities. It has been suggested that DEC develop a greater overall capability for environmental planning leadership in power plant siting matters rather than merely reviewing the utilities' proposals. This greater leadership role may evolve out of accelerated land and water resources planning and coastal zone planning.[2]

Ohio - The State of Ohio has one of the most aggressive power plant siting programs of the Great Lakes States. The Ohio Power Siting Commission, created in 1972, was established to control the location of major utility facilities. The Ohio Environmental Protection Agency Director

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[1]Southern Interstate Nuclear Board, Power Plant Siting in the United States, September 1974, p. 187.

[2]Personal communication, Charles Morrison, Department of Environmental Conservation, December 17, 1974.

serves as chairman of the Commission and several other directors of state agencies are members. The Commission has jurisdiction over the siting of both electric power plants and transmission lines. Utilities must obtain a Certificate of Environmental Compatibility and Public Need and must include a proposed site and an alternate site for evaluation in their application. The application must be filed two to five years in advance of construction of the electric generating facility. The Power Siting Commission has the final decision in the approval or denial of the utilities application.

At the present time, the Siting Commission does not have the statutory authority for pre-designation of potential sites. However, an on-going task force is currently investigating the feasibility of pre-designation of sites and a report should be forthcoming. The task force is also evaluating both fee simple and development rights acquisition of potential sites.[1] The Commission has a professional staff of approximately 20 people and also works very closely with the Department of Natural Resources and the Ohio EPA. The Commission is currently formulating their siting criteria which will include both economic advantages and environmental considerations, and will emphasize the imperative need for openness in the entire siting process.[2]

Pennsylvania - The Commonwealth of Pennsylvania does not have a comprehensive power plant siting law. The Pennsylvania Department of Environmental Resources has recently completed a Draft Master Environmental Plan for the Commonwealth which includes land capability planning. During the

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[1] Personal communication, William Blinn, Executive Secretary, Ohio Power Siting Commission, December 15, 1974.

[2] Ibid.

1974 legislative session, a siting bill similar to that of Ohio was introduced but was not passed. One impediment to state-wide regulation of the siting of power plants is the prevalence of very strong "home rule" philosophy towards land use planning.[1]

The Commonwealth of Pennsylvania currently has a number of environmental protection and management programs. Under the Pennsylvania constitution, the State is a trustee of all natural resources. The state is currently utilizing a permit system to control thermal discharges, air and water pollution, and encroachment on floodplains. All construction projects must comply with the provisions of the State Erosion and Sedimentation Act. Despite these various permitting systems, the state feels it needs more control over development; and land use legislation, including power plant siting legislation, will probably be introduced in the next legislative session.

Wisconsin - A one-stop power plant siting bill sponsored by Wisconsin Governor Lucey's office was introduced in 1972 but was not adopted by the legislature. Three more siting bills were introduced in the 1973 legislative session but, again, none were adopted. One of these bills, Assembly Bill 814, required public utilities to submit and get approval from the Public Service Commission for comprehensive ten-year plans for future sites and energy production. This same bill received a great deal of attention during the 1974 legislative session, but the House and Senate could not agree on certain provisions.

Presently, the Wisconsin Public Service Commission exerts a certain amount of control over power plant siting. Utilities must obtain a Certificate of Authority from the Commission which includes a need, cost, and reliability assessment. Further, under the Wisconsin Environmental Protection Act, the

[1]Personal communication, William Frazier, Department of Environmental Resources, December 15, 1974.

Public Service Commission prepares environmental impact statements for power production facilities and evaluates alternative sites. The Public Service Commission works closely with the Department of Natural Resources on these impact statements. The Public Service Commission's environmental impact statement is a powerful decision-making tool. These impact statements include transmission line corridors and emphasize the impacts on the environment and land use. Wisconsin does not presently have a one-stop licensing process, but the Public Service Commission endeavors to coordinate licensing between themselves and the Department of Natural Resources; and the Commission does have the final determination in siting considerations.[1] The Public Service Commission staff utilizes existing information and data pertaining to environmental impacts, generation alternatives, and siting considerations where possible. The utilities may be required to collect additional information. The Public Service Commission is responsible for formulating supply and demand projections. The Wisconsin Department of Natural Resources is currently responsible for determining the need for supplemental cooling.

Power plant siting legislation is expected to be introduced during the 1975 legislative session. This legislation will probably include requirements for ten-year plans and alternative sites, certain energy efficiency standards, control measures over utilities' research funding, and coordination of licencing between the Department of Natural Resources and the Public Service Commission.[2] This siting legislation is considered to be more of a policy tool rather than a one-stop licensing and siting control mechanism.

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[1] Personal communication, Richard Timm, Wisconsin Public Service Commission, December 17, 1974.

[2] Ibid.

CHAPTER SEVEN

FEDERAL LAWS AND LICENSING PROCEDURES RELEVANT TO POWER PLANT SITING

Federal Influence in Power Plant Siting

According to Stoel, "The Federal government has asserted only limited general authority over energy production."[1] However, several Federal agencies, including the Nuclear Regulatory Commission (old AEC), Federal Power Commission, Environmental Protection Agency, Corps of Engineers, and the Fish and Wildlife Service, are involved in various licensing and permitting programs and may influence the location or design of nuclear or fossil fuel plants and hydroelectric and pumped storage facilities. The following table presents a summary of Federal statutory authority relevant to power plant siting decisions. In addition to this, the Corps of Engineers and Bureau of Reclamation construct and operate hydroelectric facilities.

The landmark piece of environmental legislation, the National Environmental Policy Act of 1969 (P.L. 91-190) has exerted a tremendous influence in energy related decision making. The Act defines, in broad terms, what the national environmental policy will be, requires certain action by Federal agencies conducting the programs that significantly affect the quality of the environment, specifies the mechanism for implementing this requirement, and establishes the Council on Environmental Quality to provide guidance and supervision with the Act's implementation. The Act has been in effect for nearly four complete years, with several sets of guidelines for preparing environmental impact statements promulgated, and the

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[1] Stoel, Thomas, "Energy", in Federal Environmental Law, 1974, p. 961.

TABLE FOUR

FEDERAL STATUTES AND REGULATIONS
RELATED TO SITING OF ELECTRICAL ENERGY FACILITIES

Nuclear Power Plants

AGENCY	PERMIT OR REVIEW	ACT	CITE	REGS
1) NRC	Construction permit	Atomic Energy Act 1954, Sec. 103	42 USC 2133/2134	10 CFR
2) NRC	Operating license	" "	42 USC 2134	
3) NRC	Impact statement (EIS)	Nat. Env. Policy Act 1969	42 USC 4332	Appendix D to CFR part 50
4) NRC	Limited work authorization (LWA)			
5) NRC	Licenses for source, special nuclear, by-product materials			
6) Corps	Dredging permit-intake & discharge facilities	Rivers & Harbors Act-1899 Sec. 10	33 USC 403	33 CFR 209
7) Corps	Dredging permit-barge landing facilities	" "	33 USC 403	33 CFR 209
8) Corps	Approval of construction	" "	33 USC 403	
9) Corps	Permission to install structures possibly hazardous to navigation	" "		33 CFR 209
10) Corps	Permission to take soil samples below mean high water level	" "	33 USC 403	33 CFR 209
		" "		
11) Corps	Permit for disposal of dredged material	FWPCA Amend. 1972, Sec. 404	33 USC 1344	
12) Corps	Permit for transport of dredged material	Marine Protection Act '72, Sec. 103	33 USC 1413	
13) EPA	Discharge permit	FWPCA Amend. 1972, Sec. 402	33 USC 1342	40 CFR 124
14) Coast Guard	Permit for construction of obstructions to navigation			
15) Coast Guard	Permit for vessels to carry explosives			33 CFR 126:19
16) FAA	Permission to light meteorological towers & structures			FAR 77
17) USFWS	Review & comment on AEC & Corps permits actions	Fish & Wildlife Coord. Act 1958	16 USC 661	
18) NOAA	Reviews actions by agencies which might affect marine life.			

Fossil Fuel Power Plants

Agency	Permit or Review / Act
1) Corps	Permits for activities in or affecting navigable waters (dredging, structure installation, etc.)/ Rivers and Harbors Act 1899
2) Corps	Impact statement (EIS) / National Environmental Policy Act 1969
3) EPA	Water discharge permit, air emission control (where national standards apply) / FWPCA Amend. 1972, Clean Air Act 1970
4) USFWS	Reviews Corps permit granting actions and recommends stipulations to be included in permits/Fish and Wildlife Coordination Act 1958

Hydroelectric Power Plants

Agency	Permit or Review / Act
1) FPC	Issues preliminary certificates and licenses for construction and operation of non-federal hydro projects on waters or lands subject to federal jurisdiction / Federal Power Act of 1920, amended 1935
2) FPC	Impact statement (EIS) / National Environmental Policy Act 1969
3) USFWS	Provides advice and assistance with regard to proposed FPC certificate actions and recommends stipulations
4) Forest Service	Issues permits for use of Forest Service Lands

Transmission Lines

1) NRC: Considers power line routes in granting construction license

2) FPC: Considers power line routes in authorizing construction of primary lines from licensed non-federal projects on lands subject to federal jurisdiction

3) Forest Service: Grants rights-of-way across land it administers

4) Bureau of Land Management: Grants rights-of-way across lands it administers

5) Corps: Grants permits for stringing of lines across navigable waters

6) Fish & Wildlife Service: Provides advice and assistance regarding proposed right-of-way granting actions by BLM or Forest Service; same for Corps permit granting actions

Source: Federal Environmental Law, Environmental Law Institute, 1974.

Draft Report on Power Plant Siting Legislation, New England River Basins Commission, August 1974.

Act has been litigated in hundreds of court cases which have yielded diverse and often conflicting interpretations.

NEPA has had very far-reaching repercussions upon the manner in which Federal agencies consider the environmental impact of planning and implementing their programs. The policies stated in the Act are backed by specific requirements for action, including the Section 102 statements (i.e., Environmental Impact Statements--EIS) which must analyze the environmental consequences of specific actions. By requiring Federal agencies to use all available means in protecting environmental values, NEPA has had the effect of reordering priorities to include environmental considerations and traditional economic benefit cost analysis.

The landmark NEPA case, Calvert Cliff's Coordinating Committee, Inc. v Atomic Energy Commission resolved several important issues and greatly influenced Federal energy-related decision making.[1] The court ordered the Atomic Energy Commission to give more complete attention to the environment in its internal review process. The court interpretated NEPA as a mandate to achieve "a finely tuned and systematic balancing analysis" in each instance of the EIS. In very harsh words, the court said "The Commission's crabbed interpretation of NEPA makes a mockery of the Act." Further, the court said, "NEPA was meant to do more than regulate the flow of papers in the Federal bureaucracy." The court also stated that "NEPA requires that an agency must, to the fullest extent possible under its other statutory obligations, consider alternatives to its actions which would reduce environmental damage." Thus, in very strong language, the court defined the scope of the NEPA mandates and ordered a powerful Federal agency to comply with

[1] D. C. CIR. 449 F. 2d 1109, 1971.

them immediately. Other powerful Federal agencies, such as the Corps of Engineers and the Soil Conservation Service, have subsequently revised their environmental review process in accordance with this court decision, and NEPA continues to exert an influence on Federal decision making.

Energy-related activities have and continue to be influenced by the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) which defines a national plan for cleaning the country's waters by the early 1980s.[1] The impacts of thermal discharges from power plants are evaluated by the Federal Environmental Protection Agency or by an appropriate state agency where the powers under the Act have been delegated to the states. The primary emphasis of the Act is the control and abatement of polluting discharges through standards of technological control and of ambient water quality which will, among other requirements, insure the protection and propogation of a balanced population of fish and shellfish. Under Section 301 of the Act, best practicable control technology is required by July 1, 1977 at point source discharges, and best available technology is required by July 1, 1983.

The issue of what control technology is appropriate for thermal discharges has been a complex and controversial one. Recently, the Environmental Protection Agency promulgated Effluent Guidelines and Standards which stipulated that closed cycle evaporative cooling, either mechanical draft towers, natural draft towers, or cooling ponds, is currently considered the best practicable technology.[2] The situation is further complicated, however,

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[1] 33 U.S.C. 1151 et. seq.

[2] U.S. Environmental Protection Agency, "Effluent Guidelines and Standards", 39 F.R. 196, October 8, 1974.

by Section 316 which makes an exception to this rule with respect to thermal discharges. Under Section 316, whenever the operator of a power plant can conclusively demonstrate that a balanced, indigenous population of fish, shellfish, and wildlife will be maintained in the water body with a greater thermal discharge than allowed by the general regulations, the Environmental Protection Agency or the state, depending on which issues the permit, may allow an appropriately greater thermal discharge. Recent EPA guidelines state that,[1]

> "Such a demonstration may be accomplished by showing that the desired alternative effluent limitation (taking into account the interaction of such thermal component with other pollutants) will assure the protection and propogation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made."

According to Clark,[2]

> "In estimating the impact of the 1972 FWPCAA, it is important to remember that the statute is extraordinarily complex and very recent. Until a background of administrative precedents are built up in such a law, it is difficult to predict how particular parts are to be interpretated. The enforcement and interpretation of the FWPCAA will be further complicated by the delegation of authority to the states."

A fairly comprehensive analysis of the amendments is provided in the "Federal Water Pollution Handbook: A Citizen's Guide to the Federal Water Pollution Control Act Amendments of 1972."[3] According to an expert in thermal impact research, a very difficult question raised by the Section 316 exemption will be the effects of subtle changes which are occurring in aquatic environment as a result of increased thermal dissipation.[4] This controversy is by no

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[1] U.S. Environmental Protection Agency, "Thermal Discharges", 39 F.R. 196, October 8, 1974.

[2] Clark, John, Electric Power Plants in the Coastal Zone: Environmental Issues, p. VII-1.

[3] Natural Resources Defense Council, 1973.

[4] Personal communication, Dr. Richard Cole, Michigan State University, December 16, 1974

means resolved, and certainly will be the subject of continuing dispute and litigation for years to come.

During 1974, the Energy Reorganization Act of 1974 (P.L. 93-438) was adopted at the Federal level. This Act assigns most of the non-regulation functions of the Atomic Energy Commission to the Energy Research and Development Administration. The Act also establishes the Nuclear Regulatory Commission which will have major responsibilities for insuring the safety and reliability of nuclear reactors. The main purpose of the Act is to reorganize and consolidate certain functions of the Federal government in order to promote more efficient and objective management of energy research and atomic power regulation. The effective date of this Act is February 11, 1975 and it is not yet clear what impact this legislation will have on power plant siting or energy development in the United States.

Under Section 207 of this Act, the Nuclear Regulatory Commission is directed to conduct a national survey to locate and idenfity possible nuclear energy center sites, which are often called "power parks". This survey is to include a regional evaluation of natural resources, possible environmental impacts resulting from these nuclear energy centers, and consideration of the use of certain Federally-owned properties for energy centers. This report is due to be published and transmitted to Congress not later than one year from the date of enactment of this legislation. The report is to include the Commission's evaluation of the results of the survey and any conclusions and recommendations for legislation the Commission deems desirable.

Proposed Federal Power Plant Siting Legislation

Since 1971, several pieces of power plant siting legislation have been introduced at the Federal level. The Nixon Administration introduced HR 5277 as a proposed Power Plant Siting Act of 1971. Provisions of this bill included the establishment of a single state certifying agency which

would review ten-year plans and five-year site inventories prepared by utility companies. The Administration's bill did not provide for a one-stop Federal certification process, and while the bill stipulated that the states should have the primary responsibility for power plant siting decisions, they must follow Federally imposed criteria. Under this proposed bill, the hypothetical Federal Department of Natural Resources would be given the major responsibility for administration of the Act, and would also have the final decision making authority with respect to siting of all types of electric power plants. Extensive hearings were held on this proposed bill, as well as three similar Senate bills.[1]

Several power plant siting bills were introduced in the 1974 legislative session. Congressman McCormick introduced HR 12283 which included the following provisions: state review and authority for certification of nuclear power plant sites, simplification of the Atomic Energy Commission licensing procedure, authorization of the AEC to consider and designate sites in advance of need, and requirement for AEC to make a national survey of nuclear power park sites. The Federal Energy Administration's draft "Energy Facilities Siting and Development Act of 1974" contained provisions for facilitating Federal processing through single composite Federal applications. This bill also authorized state program development and administrative grants for management programs oriented to the designation of energy facility sites and encourages states to take the initiative in designating sites suitable for facilities. This bill set would have established a loan fund for states to borrow money to identify and acquire acceptable power plant sites. This particular bill, postulated in M. 232, was never introduced to

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[1] Committee on Commerce, U.S. Senate Hearings on Power Plant Siting, April 28, May 15, June 1, 1972.

Congress, but may receive further attention during the next legislative session.[1]

The future of Federal power plant siting legislation is uncertain at the present time. New Federal legislation will almost certainly be introduced in the 1975 session in an effort to simplify the current licensing morass and encourage states to become actively involved in siting of power facilities. The current trend appears to be towards legislation similar to the proposed National Land Use Planning Act and the present Coastal Zone Management Act. This type of legislation would provide funds to states to encourage them to develop power plant siting planning and management programs. The administration portion of this type of legislation could conceivably provide Federal funding for acquisition of power plant sites. In any case, the states will probably retain the major responsibility for power plant site regulation.

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[1] Coastal Zone Management, November 20, 1974, p. 4.

CHAPTER EIGHT

COASTAL ZONE MANAGEMENT AND POWER PLANT SITING

The Coastal Zone Management Act of 1972

Intelligent coastal zone management demands a comprehensive land and water resources planning and policy perspective. The United States Coastal Zone Management Act of 1972 (P.L. 92-583) provides a medium for achieving comprehensive management of the valuable coastal zones in the United States. The Act provides Federal funding for coastal zone planning and management program development. The Act strives to strike a balance between the economic values of the coastal zone and the ecological importance of the coastal zone. The states are instructed to prepare management programs which minimize ecological damage in the coastal zone, while providing the opportunities for reasonable economic development and utilization of the coastal zone. The Act requires that the states include lands that have a direct and significant impact on the coastal zone in the management programs. The waters and coastal bottom lands designated by the Act are those that the state has jurisdiction over.

The Act contains several very specific procedural and substantive provisions. Section 305 of the Act authorizes the Secretary of Commerce to make annual grants to any coastal state for the purpose of developing a coastal zone management program. Section 306 authorizes the Secretary to make annual grants for the administration of the state's coastal zone management program. Section 312 makes grants available to coastal states for the cost of acquisition, development, and operation of estuarine sanctuaries which are to be natural field laboratories oriented towards ecological research. A state coastal zone management program, under the provisions of Section 305 (b) must include:

1. an identification of the boundaries of the coastal zone subject to the management program;

2. a definition of what shall constitute permissible land and water uses within the coastal zone which have a direct and significant impact on coastal waters;

3. an inventory of and designation of areas of particular concern within the coastal zone;

4. an identification of the means by which the state proposes to exert control over the land and water uses, including a listing of relevant constitutional provisions, legislative enactments, regulations, and judicial decisions;

5. broad guidelines on priority of uses in particular areas including specifically those of lowest priority;

6. a description of the organizational structure proposed to implement the management program.

Of particular importance to the issue of power plant siting, Section 306 (8) requires that the management program "provide for adequate consideration of the national interests involved in the siting of facilities necessary to meet requirements which are other than local in nature." Further, Section 307 (c) (1) requires that "Federal agencies conducting or supporting activities directly affecting the coastal zone shall conduct or support those activities in a manner which is to the maximum extent practicable consistent with approved state management programs." The states are also required to incorporate in their management program the policies of the Federal Water Pollution Control Act and the Clean Air Act.

Regulations recently promulgated by the Office of Coastal Zone Management (N.O.A.A.) have served to further clarify the specific requirements of the states' coastal zone management programs.[1] Several sections of these regulations are directly relevant to the issue of power plant siting and

[1] U.S. Dept. of Commerce, 40 F.R., no. 6, January 9, 1975, pp. 1683-1695.

its relationship to coastal zone management. Section 923.4 requires that a comprehensive management program should have considered issues pertinent to energy generation and transmission. Section 923.12 contains the requirement that the state must develop a procedure for defining "permissible land and water uses within the coastal zone which have a direct and significant impact upon the coastal waters" which should include an analysis or establishment of a method for analysis of the capability and suitability for each type of resource and application to existing, projected or potential uses, as well as an assessment of the environmental impact of these resource uses. Section 923.15 includes the requirement that a state management program must consider the siting of facilities which are greater than local concern. This section specifically includes energy production and transmission facilities, including nuclear, conventional, and hydroelectric power plants. The regulations state, however,

> "The requirement should not be construed as compelling the states to propose a management program which accommodates certain types of facilities, but to assure that such national concerns are included at an early stage in the states' planning activities and that such facilities are not arbitrarily excluded or unreasonably restricted in the management program without good and sufficient reasons."

The regulations also suggest that the states should consult with adjacent and nearby states which share similar or common coastal resources to determine how regional needs may be met in siting of facilities.

These regulations also include a discussion of the techniques for control of land and water uses which can be utilized by the states in administration of the management programs. One method would be state establishment of criteria and standards for local implementation subject to administrative review and enforcement of compliance at the state level.

Another mechanism would be direct state land and water use planning and regulation which preempts the traditional role of local government in the zoning process involving land or waters within the coastal zone. A third technique would be state administrative review for consistency with the management program of all development plans, projects, or land and water regulations including exceptions and variances with state power of approval or denial. Section 923.26 of the regulations specifies that the state may choose to utilize only one of the techniques, or more than one, or a combination of them in different locations at different times.

An additional section of the regulations pertaining to power plant siting is Section 923.44--Applicability of Air and Water Pollution Control Requirements. The state management program must be developed in close coordination with the planning and regulatory systems being implemented under the Federal Water Pollution Control Act and the Clean Air Act. The regulations point out that there is a significant opportunity for developing working relationships between air and water quality agencies and coastal zone management programs. Several of these opportunities include joint development of Section 208 area waste treatment planning, consolidation of various regulatory programs, coordination of monitoring and evaluation activities, and consultation regarding state water quality standards setting. The states' management programs should provide for continuing coordination and cooperation with air and water programs during program development and management administration. According to Reitz, the broad definition of the terms point source and pollutant under Section 512 of the FWPCAA indicates that virtually every activity affecting water resources of the coastal zone will be subject to a state or Federal permit program, and therefore, a

significant regulatory mechanism is available to the states.[1]

Great Lakes States Coastal Zone Management Programs and Power Plant Siting Issues

During the first year of the coastal zone planning activities, the seven Great Lakes States involved in coastal zone management are inventorying their coastal resources for opportunities and constraints to development. Three main types of inventory activities are currently underway. All seven of the Great Lakes States are presently analyzing their respective coastal zones for various land and water resource issues and pressures.[2] This inventory will identify various recreational and development pressures on the coastal zone and presents an excellent opportunity to assess the magnitude of power plant siting problems. A second type of inventory that all seven states are currently involved with is a legal and statutory analysis of state and local control over the coastal zone.[3] This inventory will identify existing gaps and overlapping in statutory authority, and presents the opportunity to assess the need for additional power plant siting legislation. All seven states are also currently involved in a physical resources inventory of the coastal zone.[4] This coastal inventory will include both physical and ecological processes and the evaluation of environmentally critical areas, areas of particular concern such as lands subject

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[1] Reitz, Arnold, Environmental Planning: Law of Land and Resources, 1974, pp. 2-5.

[2] Illinois, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, Coastal Zone Management Development Program Initial Grant Applications, 1974.

[3] Ibid.

[4] Ibid.

to erosion or flooding, coastal zone boundary determination, and historical and cultural features of significant importance. This physical inventory presents an excellent opportunity to assess the capability and suitability of the various sections of the coastal zone for power plant siting considerations.

The second and third years of the Great Lakes States coastal zone management development programs will consist largely of formulating the desired management plan, securing the necessary additional statutory authority for exercising control over the coastal zone, involving the public in the planning process and obtaining public support for the management plan, and organizing and establishing the necessary institutional mechanism for implementation of the management plan. The State of Michigan intends to accomplish this management program development in two years and the other Great Lakes States will utilize the full three years authorized in the statute. Following approval of the management plan by the Secretary of Commerce, the states may secure funding for administration of the coastal zone management program for a period not to exceed five years. The intent is to insure the development and implementation of a viable state coastal zone management program, rather than the proverbial dust gathering plan which sits on a shelf.

There is obviously a very direct relationship between coastal zone management and power plant siting issues. It is still somewhat early, however, to determine exactly what the precise relationships will be. All of the Great Lakes States are aware of the importance of the power plant siting problem, and are in various stages of resolving it. The states of Illinois, Michigan, Minnesota, New York, and Pennsylvania intend to address

the specific issues of power plant siting subsequent to the completion of their physical and legal inventorying process. The State of Indiana is not presently involved in coastal zone management, but they are currently considering submitting a first-year program development grant application.[1] The States of Ohio and Wisconsin are analyzing power plant siting issues in the first year of their respective coastal zone management programs. The Ohio Power Siting Commission intends to utilize the Ohio coastal zone management inventory information to evaluate various utilities' proposals.[2] The Siting Commission and the Ohio Shorelands Division will be working closely to develop power plant siting policies and criteria for the Ohio coastal zone.[3]

In Wisconsin, the Public Service Commission is currently analyzing various relationships of power plant siting and coastal zone management. Under a contract from the Office of State Planning, lead agency for coastal zone management in Wisconsin, the Public Service Commission will compare key impacts of power plant siting in the coastal zone as opposed to inland siting.[4] The Public Service Commission will also delineate several alternative power plant siting policies for Wisconsin's coastal zone. The State of Wisconsin considers transmission corridor location to be an extremely important factor and this will also be evaluated in this study.

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[1]Personal communication, William Watt, Executive Assistant in the Office of the Governor, December 31, 1974.

[2]Personal communication, William Blinn, Executive Secretary, Ohio Power Siting Commission, December 15, 1974.

[3]Personal communication, Gary Turner, Administrator, Ohio Shorelands Management Section, October 9, 1974.

[4]Personal communication, Richard Timm, Wisconsin Public Service Commission, December 17, 1974.

Power plant siting is an extremely important issue in coastal zone management in the Great Lakes. The states involved in coastal zone management in the Great Lakes are aware of the importance of this problem and fully intend to address it in their management program formulation.

CHAPTER NINE

CURRENT POWER PLANT SITING RELATED RESEARCH IN THE GREAT LAKES REGION

A tremendous number of scientists throughout the Great Lakes Region are conducting research programs pertinent to power plant siting issues. The following sections present a brief overview of these state, Federal, university, and private research activities.

State Research Activities

As discussed in Chapter Eight, seven Great Lakes States are currently conducting extensive physical resources and legal authorities inventories in conjunction with their coastal zone management programs. Much of this information will be directly relevant to power plant siting issues. In addition, many state water quality control agencies are currently conducting thermal impact assessment studies and may be in the process of establishing thermal discharge standards under the FWPCAA. In conjunction with this standard setting, many state fisheries divisions are conducting inventories to determine the natural species diversity and abundance conditions of the fishery resources.

Several state public service commissions are presently engaged in various research projects and studies related to power plant siting. The Wisconsin Public Service Commission is currently studying the impacts of both coastal and inland power plant siting, and subsequently, will formulate several alternative policies for coastal zone power plant siting. The Ohio Power Siting Commission is currently analyzing the feasibility of pre-designation of power plant sites and is considering both fee simple acquisition and development rights acquisition. The New York Public Service Commission has recently completed a pilot power plant site survey and tentatively plan to

survey the remaining portions of the state for potential power plant sites within the next year.

Federal Research Activities

Several Federal agencies are intimately involved in power plant siting and related research. The Environmental Protection Agency--Region V, is currently sponsoring a Lake Michigan Cooling Water Studies Panel which is composed of a large number of eminent scientists concerned with various aspects of thermal discharges. The Panel is attempting to prepare a comprehensive and realistic program which analyzes the effects of cooling water use on Lake Michigan and increases the fundamental ecological knowledge of the region. EPA has sponsored a five-year research project investigating the utilization of thermal cooling water for agricultural usage, including frost protection, undersoil heating, greenhouse applications, double cropping, plant cooling, and humidity control.[1] The Environmental Protection Agency also sponsors a number of research activities related to thermal dissipation in the Great Lakes.

The Atomic Energy Commission, through its Argonne National Laboratory, has sponsored several research programs relevant to thermal discharge into Lake Michigan. For several years, Argonne scientists have been analyzing the radiological and environmental impacts of thermal discharges from nuclear power plants.[2] The Energy and Environmental Systems division of Argonne National Laboratory has, for several years, conducted a research project which attempts to analyze the cumulative impacts of thermal discharges

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[1] U.S. Environmental Protection Agency, A Demonstration of Thermal Water Utilization in Agriculture, Environmental Protection Technology Series, April 1974.

[2] Argonne National Laboratory, Radiological and Environmental Research Division Annual Report, January-December 1973.

from power plants surrounding Lake Michigan. The project has been concentrating on the environmental status of the Lake Michigan region to establish a baseline for the overall impact assessment. The soils, earthquake history and measurement, and mammals of the Lake Michigan region have been compiled and reports published during 1974. Various Argonne scientists have been involved in thermal plume analysis and thermal effluent modeling studies in recent years.[1] Argonne National Laboratory is currently involved in an Energy Regional Studies Program sponsored by the Atomic Energy Commission. This program will focus on an assessment of health and environmental impacts associated with energy resource development, energy facility siting, and operation. The program is just now getting underway, but preliminary indications are that this may be a very useful endeavor.

The Council on Environmental Quality has sponsored several investigations of importance to energy issues in the Great Lakes. CEQ sponsored the development of a data base which quantifies the environmental effects of each component of a large number of energy systems, and the comparative energy systems efficiency. This data base is called MERES, which stands for Matrix of Environmental Residuals for Energy Systems. The Council also has recently formulated their Half and Half Plan, which attempts to establish a national energy plan which emphasizes energy conservation, improved efficiency, elimination of waste, and environmental protection. The plan calls for half the per capital rate of growth in energy consumption to be coupled with the energy conservation program.[2]

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[1]Tokr, J. V., Thermal Plumes in Lakes: Compilations of Field Experience, Argonne National Laboratories, August 1971, and Policastro, A. J., Heated Effluent Dispersion in Large Lakes: State of the Art in Analytical Modeling, Argonne National Laboratories, January 1972.

[2]Council on Environmental Quality, Fifth Annual Report, December 1974. pp. 475-477.

The United States Department of the Interior Fish and Wildlife Service is currently involved in several energy related research activities. The Fish and Wildlife Great Lakes Fishery Laboratory, located in Ann Arbor, Michigan, is investigating the impacts of temperature and food availability on the growth of Coho salmon, respiratory and metabolic impacts of thermal discharges, fishes attraction and avoidance of thermal discharges, impacts of temperature increases on survival of eggs and fry of Lake Trout, and several other general fisheries research studies. The Great Lakes Environmental Research Laboratory (N.O.A.A.) also located in Ann Arbor, is responsible for a tremendous amount of limnological research, modeling efforts, and Great Lakes ecological studies, many of which are directly relevant to thermal impact assessment. The Great Lakes Environmental Research Laboratory is also the lead U.S. agency in the International Field Year on the Great Lakes Study of Lake Ontario, in which a tremendous amount of limnological and ecological information was collected and is currently being analyzed.

The Canadians are also involved in research activities relevent to power plant siting issues. Scientists at the Canada Center for Inland Waters in Burlington, Ontario, are conducting extensive research into various physical and ecological impacts of thermal dissipation and power plant entrainment. At the present time, however, the data is either incompletely analyzed, or suffering from a lack of research during certain critical periods.[1] In the near future, however, more definitive results of CCIW's waste heat research should be available.

During March of 1975, the second Interagency Committee on Marine Science and Engineering (ICMSE) Conference on the Great Lakes will be held. The

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[1]Personal communication, Dr. J. R. M. Kelso, Canada Center for Inland Waters, December 4, 1974.

principal emphasis of this conference will be energy related research activities in the Great Lakes. The topics to be considered at the conference are: sources and emissions, atmospheric transport and removal processes, aquatic transport and removal processes, ecological impacts, and effluent control technology. This conference will include the participation of many scientists and managers concerned with environmental impacts of energy production and thermal dissipation and should provide a tremendous amount of valuable information.

University Research Activities

A number of universities, including three of the four Great Lakes Sea Grant institutions, are involved in power plant siting research activities. The University of Wisconsin Sea Grant Program has five electric power research studies presently underway. These studies are principally concerned with the physical characteristics and biological impacts of thermal plumes. The sedimentation and erosion caused by a nuclear power plant has also been the subject of a research study in the Wisconsin Sea Grant Program.[1] Aerial remote sensing of thermal pollution in Lake Michigan has been the subject of a University of Wisconsin Institute for Environmental Studies research project.[2]

Dr. John Ayers of the University of Michigan Great Lakes Research Division has conducted extensive research investigations into the impacts of thermal discharges in the Great Lakes. Researchers at the University of Michigan Sea Grant Program are conducting various research projects in Lake Michigan, Saginaw Bay, and Grand Traverse Bay, which include modeling

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[1] Pezzetta, John M., "Sedimentation Off the Kewaunee Nuclear Power Plant", University of Wisconsin Sea Grant College Program, Technical Report No. 221, March 1974.

[2] Green, Theodore, "Thermal Plumes in Lake Michigan", Great Lakes Basin Commission Communicator, December 1973, p. 5.

efforts, ecological analysis, and limnological studies, which could prove to be very valuable for thermal impact assessment. Researchers at the University of Michigan Coastal Zone Laboratory are presently analyzing a wide variety of coastal processes.

Scientists in the New York Sea Grant Program are involved in several studies relevant to power plant siting on Lake Ontario. Studies currently underway include an assessment of state policies pertaining to power plant siting, social-legal and organizational dilemmas in power plant siting, environmental protection and regional economic growth regarding coastal zone power plants, and modeling and analysis of systems to utilize heated effluents. Another very interesting research project, due to be completed in September of 1975, is the multiple utilization of power plant buffer zones and transmission corridors.[1] Also scheduled for completion in September 1975 is a study involving modeling of biological impacts of thermal discharges in Lake Ontario. Many of these thermal impact studies conducted on Lake Ontario should be applicable to the other Great Lakes.

Private Research Efforts

Many private entities are involved in studies relevant to power plant siting issues. Many private utilities conduct extensive site inventories and environmental impact assessments. In addition, utilities frequently contract with universities for environmental impact assessments or thermal research. As an example, Consumers Power Company is contracting with Michigan State University in a three-year study to determine the feasibility

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[1] New York Sea Grant Program, Annual Report, 1973-1974, pp. 31-47.

of waste heat utilization in agriculture. Detroit Edison is also contracting with Michigan State University in a five-year study to determine the environmental impacts of thermal discharges into the west end of Lake Erie. General Electric Company, under a National Science Foundation grant, is conducting an electric generating plant siting study involving dispersed siting and energy parks. The intent of this study is to compare the environmental impacts and economics of these two forms of power plant siting. This study is due to be completed in March of 1975.

The Environmental Research Institute of Michigan, a non-profit private corporation, has conducted extensive research into the use of multi-spectoral scanning and remote sensing of thermal discharges. In a study sponsored by the Michigan Department of Natural Resources, ERIM monitored thermal plumes at selected locations in the southern peninsula of Michigan during several seasons of the year.[1] ERIM has also utilized remote sensing technology in a number of coastal zone studies and limnological studies associated with the IFYGL project.

Consulting firms represent another source of environmental research and technological development relevant to power plant siting issues. Frequently, consulting firms, as a result of contracts with utilities, develop sophisticated environmental impact assessment and power plant siting selection methodologies. In addition, several consulting firms are considered to be leaders in the field of transmission corridor selection. The intense competition among consulting firms frequently results in innovative technological and methodological developments which leads to an overall improvement of the quality of environmental impact assessment and power plant siting decisions.

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[1] Environmental Research Institute of Michigan, Power Plant Discharges and Thermal Anomalies in Southern Michigan--Project Summary, March 1974.

CHAPTER TEN

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Projections for future energy requirements necessitate increases in energy production. Power plant siting issues, one facet of this increased energy production, represent extremely complex natural resources and social conflicts and problems. Increased energy production frequently causes tremendous aquatic, terrestrial, meteorological, social, and economic impacts. However, rational solutions for these energy related problems exist in intelligent siting and design of electric generation and transmission facilities to minimize environmental impact. Further, once-through cooling systems should not be arbitrarily eliminated in the Great Lakes. The thermal assimilative capacity of the Great Lakes is a resource and should be utilized provided that no significant detrimental environmental degradation occurs. It should be recognized that once-through cooling may have the least environmental impact, and certainly has the least economic and energy cost of the alternative cooling systems presently available.

In order to accommodate reasonable increases in energy production and yet assure the maintenance and enhancement of a high quality environment, while minimizing conflicts in land and water resource utilization, we must accelerate planning and policy implementation. A combination of intelligent water and land resource planning and management, including power plant siting and thermal impact analysis and monitoring, coupled with more efficient energy production and energy conservation methods, will facilitate the attainment of these goals. State power plant siting legislation and coastal zone management programs represent viable mechanisms for conducting the required planning and management actions. It is of the utmost importance that these programs

and planning activities be initiated at the present time while the greatest number of possible alternatives is still available.

Recommendations

1. A national energy policy which includes energy conservation measures, comparative analysis of the relative environmental impacts and energy systems efficiency of alternative methods of energy production, and total benefit-cost accounting is urgently needed at the present time to serve as a framework for energy planning and policy formulation.

2. Investigation into the feasibility and economics of the so-called "clean" power sources such as solar energy should be accelerated. Further, cities should be encouraged to engage in solid waste management and resource recovery programs designed to utilize "garbage" as a supplemental source of energy production. In addition to research into alternative energy sources, the beneficial use of waste heat should be further investigated. As in the case with solid waste management programs, waste heat from power plants should be viewed as a resource rather than an environmental liability.

3. Energy related planning and policy making in the Great Lakes requires a regional planning and policy perspective and analysis. Therefore, a regional energy planning and policy study should be initiated which would include regional energy supply-demand projections, cumulative-lakewide thermal impact assessment, coordination of existing research programs and state and Federal policies and licensing procedures, and regional reliability planning. Representatives of the Great Lakes States, Federal agencies, universities, and utilities should be involved in this study.

4. The Great Lakes States should consider the desirability and political feasibility of enacting power plant siting legislation which is similar to the comprehensive Maryland siting program.

5. Presently, the uncoordinated and time-consuming process of obtaining licenses and permits, coupled with conflicting governmental authorities, represents a formidable obstacle to power plant construction. There is an urgent need to coordinate this power plant licensing at both the state and Federal levels. This licensing coordination could be conducted as part of the regional energy planning study and as a facet of state power plant siting legislation.

6. The Great Lakes States should consider power plant siting issues in the early stages of their coastal zone management program formulation. The state coastal zone management divisions should also develop a close working relationship with their state public service commissions to facilitate cooperative and coordinated power plant siting policy formulation.

7. To enable accurate cumulative thermal impact assessment in the Great Lakes, the thermal assimilative capacity of the Great Lakes must be determined. It is conceivable that this information could be derived from existing data and research studies, but additional research may be required.

8. Power plants should be prohibited from certain environmentally critical areas such as wetlands, prime breeding habitats, and valuable estuarine regions. Power plants should be sited in areas most capable of assimilating the additional environmental stresses with the least ecological damage.

9. Power plant design and engineering must be improved to minimize environmental impacts. This should include: intake and outlet structural design and location to reduce organism entrainment and impingement; reduced volume and flow rates of cooling water intake; utilization of mechanical devices, rather than chlorinated compounds, to reduce organism fouling; and increased atmospheric dispersion of thermal discharges.

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